

In harmony with nature



A teacher's handbook on learning
for sustainable living in Maharashtra

About Us

The BNHS India (Bombay Natural History Society) established in 1883, is India's best recognised environmental NGO working for conservation, through research and education. Much of the ecological information on India is an outcome of efforts of BNHS scientists and its members over more than a century. The BNHS has many achievements to its credit, ranging from the conservation of many wild species and habitats to research and documentation on mammals, birds, flora and fauna. Conservation Education has always been a primary concern of BNHS.

The Conservation Education Centre (CEC) conducts innovative and interactive educational programmes for different target groups such as children, teachers, trainers, NGOs, corporate groups, government officials etc.. The Centre has been designing and disseminating educational resources to spread awareness about biodiversity conservation. For more details log on to www.bnhs.org

The Royal Society for Protection of Birds (RSPB) was founded in 1889 and since then has grown into Europe's largest wildlife conservation society. It exists to secure a healthy environment for birds and wildlife, helping to create a better world for us all. It is a charitable organization with more than one million members, 12,000 volunteers, 1,400 staff, 188 nature reserves, 10 regional offices, four country offices, and one vision - to work for a better environment that is rich in birds and other wildlife.

The RSPB manages nature reserves so that wildlife can flourish and people can get closer to nature. It also shares its knowledge and enthusiasm to help people of all ages enjoy the natural world. This includes an extensive education programme to enable young people to learn more about the environment.

For more details log on to www.rspb.org.uk.

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A Teacher's Handbook on Learning for Sustainable Living in Maharashtra



Collaborative project
by BNHS - India and RSPB

Funded by
Sir Dorabji Tata Trust and ICICI Bank

acknowledgements

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Foreword

Dear Educators,

The BNHS has been furthering the cause of environment education over the last 120 years. It thus gives me great pleasure to introduce this book to my teacher friends. I am sure it will help you to fill several gaps in the way you are already dealing with environmental issues in your class. Perhaps it will also help you to change the way you live your own life, that of your family and your community. Think of your years as a teacher who had educated hundreds of children. Imagine what could have been achieved for our environment through them, if you had used a strong pro-environmental approach to your teaching. I have worked with teachers interested in the field of environment education for more than three decades and they have done wonders.

At Bharati Vidyapeeth Institute of Environment Education and Research an environmental content analyses of school textbooks from every State in India of standards I to X of Science, Geography, Social science and Language found that concepts related to sustainability and the need for sustainable lifestyles was nearly non-existent. We found that while the knowledge needed for teaching natural resource use in the teacher community existed the tools required to link this to action was frequently missing.

But I must caution you, Sustainable living cannot be taught it is learned through real life experiences. You will have to become an example and your students will follow your leadership. Providing students with the appropriate knowledge of our environment leads to a greater awareness of the student's own environmental assets and problems. This leads to a heightened concern, which leads to pro-environmental action.

I have often been asked, what is the most important tool for environment education. I strongly believe this is done through creating a love for Nature.

In view of the Honorable Supreme Courts initiative to introduce environment education into school curriculum teachers will have to modify their teaching techniques to create a pro environmental community for the future. As suggested in this book we need to infuse environment education into every subject and also create a separate time and space where environmental issues can be learned through a focused subject that integrates the learning from all the different subjects. We need this dual strategy to make it work.

Developing sustainable lifestyles is about explaining students how we use natural resources. What is the nature of the resource? Who uses it? How is it overused or misused? And finally how can it be conserved. It is answers to these questions that will bring about environmental consciousness. I am sure that as your students begin to change their lifestyles, you will experience the same joy that I have felt over the last three decades when young people I have had the pleasure of interacting with have become torch bearers of conservation.

I salute all the teachers who have furthered the cause of environment education over the years and are currently directing the future of India through their efforts as committed environmental educators.

I wish you all the best in helping to protect India's environment.

Dr. Erach Bharucha

Bharatiya Vidyapeeth of Environment Education and Research

Bharatiya Vidyapeeth Deemed University

Pune, Maharashtra.

Table of Contents



Introduction

- What is Sustainable Living?
- How to use this book?



Biodiversity

1 to 24

Activities



Air

25 to 44

Activities



Water

45 to 62

Activities



Soil

63 to 80

Activities



Energy

81 to 96

Activities



People

97 to 116

Activities



Useful Information

117



Introduction



*If we leave enough places in the world:
where silence is not broken with our noises,
where space is not altered with our objects,
where evolution is not interrupted with our progresses,
where misery is not consolidated because of our greeds,
we will be worthy of being part of the shared miracle of life.*

Manfred Max-Neef

Professor of the Universidad Austral de Chile

What is sustainable living?

- Sustainable living means living with an increasing awareness of how one's daily choices effect the natural environment: air, water, land, sea, plants, and animals and taking action to the reduce impact. Our daily lifestyle choices cycle back to affect one's own body through the water we drink, food we eat, air we breathe and the way we connect ourselves to our surroundings.
- In recent human history, populations in developed countries have experienced economic growth beyond any comparison in the world's past. Segments of the world's population now consume natural resources to an extent well beyond their basic needs.
- Over consumption depletes natural resources, making them unavailable for future generations (e.g., fossil fuels) and reduces the ability of the land to process waste (e.g., filling of the garbage dumps, nuclear waste).
- The natural environment gives us signs that populations are not living in balance. These signs include deforestation, soil degradation and loss of top soil, filling up of wells, inability to eat local fish, local species extinction, higher rates of asthma and other health effects due to air pollution, skin cancer due to ozone loss, and more.
- The Ecological Footprint that calculates the land required per person based on energy used, materials consumed and disposed, food production, water usage, motor fuels consumed, and built space versus open space. This tool has been used by individuals, communities, nations and the world as a whole, giving a comparable value to the carrying capacity of their respective supporting ecosystems. E.g. the largest ecological foot print is that of United States, where an individual uses 24 global acres against 12 global acres which U.S. can actually afford. For comparison, Australia's land can support 47 global acres/person and the population has an ecological footprint of 19 global acres/person. Germans have an ecological footprint of 13 acres, while countries like India have an ecological footprint of 2.
- Although India's Footprint has exceeded its domestically available biocapacity for over forty years, ecological demands have continued to grow to more than double biocapacity by 2002. The ecological deficit that exists when ecological demand exceeds supply can be financed by importing biocapacity, liquidating existing stocks of ecological capital, or allowing wastes to accumulate and ecosystems to degrade.
- We live in a society that is not living sustainably. Sustainable living promotes actions people can do in their daily lives, at work and for recreation to increase the balance between ones needs and available resources. Collectively, each individual's efforts to live sustainably add up to create sustainable communities and nations. Actions empower us and make a difference in our own life and as part of the whole.

What is the role of education for sustainability?

- The role for education for sustainability is to empower people to use their existing knowledge. In order for any changes to take place, which might shift our thinking towards environmental sustainability, we must all believe that our actions can make a difference, that we are capable of creating change. This is the empowerment that experts argue can be encouraged through environmental education as a life long process.
- It is clear that the roots of education for sustainable living are firmly planted in environmental education. While environmental education is not the only discipline with a strong role to play in the reorienting process, it is an important ally. The motto of the environmental education movement has been: "think globally, act locally".

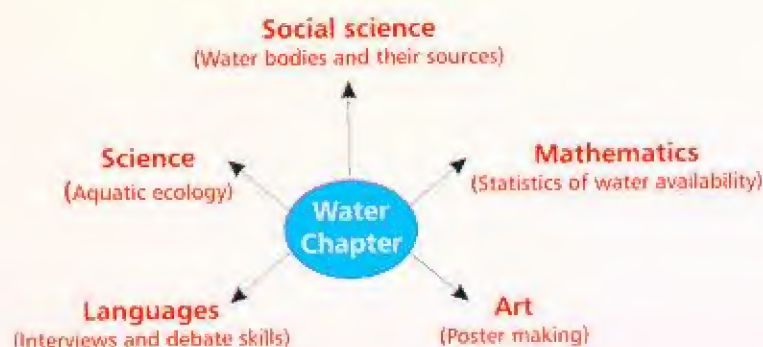
This book, 'In Harmony with Nature - a teachers' handbook on learning for sustainable living in Maharashtra' aims at empowering the teachers so that they further empower their students with the knowledge and activities on sustainable living.

How to use this handbook?

This cross-curricular book has been developed for earners of teachers of secondary school. It has been designed to provide you with support materials and activities that will help you to integrate the concept of *Sustainable Living* across the school curriculum. Students, parents and professionals are also encouraged to use this book. It has been developed after a series of workshops with teachers and in consultation with Royal Society for Protection of Birds (RSPB). The information and activities included here are not prescriptive but should be adapted to meet your needs. They cater for both the young and older age groups. Teachers and parents are encouraged to use current articles from newspapers, magazines, video films, as well as other resources, to add variety, depth and stimulate discussion. The aim of this book is to make each one of us review our lifestyles and behaviours so that we may evaluate our impact on the environment and turn our efforts into education for sustainable development. The book has been published in two languages; English and Marathi.

Integrated Learning

The themes developed in this book can be easily integrated in different subjects across the curriculum. Guidelines are provided to assist you in each thematic area. Teachers must emphasize that the guiding principles of environmental education- knowledge, skills, attitudes and values- are interlinked and are built into all the themes addressed in this book. An example is given below:



Themes of the book

- The handbook deals with six chapters namely; Biodiversity, Air, Water, Soil, Energy and People. The themes have been deliberated after a workshop with experts. Each chapter is divided into two sections; Background information and Activities. The comprehensive background information enables teachers to develop better understanding of the subject. There are set of 5-6 activities that are designed to bring out not only the attitudinal changes among the children but also encourage them to take an active role in solving or understanding their local environmental issues. The activities are action-oriented and encourage the learners to undertake research, carry out surveys and questionnaires, and participate in projects and a host of activities that take them outside the classroom.
- The language of the book has been kept simple and the presentation of the text is in a bulleted form which aids easy reading. The supporting illustration and photographs make reading the book an interesting experience. The content of individual chapters is enhanced with numerous case studies and facts. In order to make the book more relevant to Maharashtra, wherever possible the local issues have been highlighted.
- The text has been compiled from various sources which involves publications and course material of Leadership in Biodiversity Conservation of BNHS, publications of Centre for Environment Education and various websites both national and international that provide information on environmental issues.
- Glossary of technical terms is given at the end of each chapter. The technical terms are indicated in bold.
- The Giant Squirrel in a cartoon form is used as a mascot throughout the book. The Giant Squirrel, the state animal is an endangered mammal found in Maharashtra.



What is expected from the teachers?

- The chapters of the handbook include topics that are integrated with Science, Social Sciences, Mathematics, Language and Art. It is therefore expected that the teachers using this handbook should adopt integrated study approach. In order to help the teachers with this approach, the handbook has designed activities wherein the relevant subjects are mentioned. By using this method, teachers would be able to infuse the sections of the handbook into the existing curriculum. The activities would be more perceived as part of a practical session rather than an extracurricular activity.
- Teachers are encouraged to assess their performance and for the same, they need to keep record of all their work in a portfolio/file to include: worksheets used, written assignments, research project notes, reports, audio-visual materials developed such as leaflets, posters and photographs. They are also encouraged to write to us in case difficulties are encountered.

Biodiversity

"Man did not weave the web of life, he is merely a strand in it.

Whatever he does to the web, he does to himself."

Chief Seattle

Nature has provided us with five basic elements - Earth, Fire, Space, Water and Air. The universal presence of these elements affects the functioning of our body and mind. This handbook aims to influence young minds with the five elements of nature and we made a small change in replacing 'space' with 'Biodiversity'. This chapter deals with the basis of life's support system- Biodiversity.

How rich is Indian Biodiversity ?

- India is the seventh largest country in the world. We have a diverse geological range: the snowcapped Himalayan mountains, the flat Gangetic plains, hill ranges of the Aravalli, Satpura and Vindhya, the hot desert in western Rajasthan, the swampy delta in the Sunderbans, the waterways in Kerala in the south, the Western and Eastern Ghats and the Deccan Plateau.
- Landlocked on one side, we are bound by water on three other sides- the Arabian Sea, Indian Ocean and the Bay of Bengal, dotted with island clusters of the Andaman and Nicobar and the Lakshadweep.
- It is this immense physical variety that along with its location in the tropical and subtropical latitudes that has bestowed India with an inherent wealth of life, making it one of the richest nations in terms of biological diversity.



Biodiversity of India

Groups	No. of species
Mammals	372
Birds	1,224
Reptiles	408
Amphibians	197
Fishes	2,546
Protista	2,577
Molluscs	5,070
Insects	59,353
Flowering plants	15,000
Gymnosperms	64
Bryophytes	2843
Pteridophytes	1012
Algae	12480
Fungi	23000

How many types of biodiversity exist?

- In 1992, at the United Nations Earth Summit in Rio de Janeiro the word 'biodiversity' was defined.
- It simply means the variety and range of life forms on our planet- termed as 'biological diversity' or 'biodiversity'.
- Biodiversity is broadly divided into three types, species diversity, genetic diversity and ecosystem diversity. However, domesticated diversity and micro-organism diversity also form important components of biodiversity.
- The variety and differences found in living organisms of the present world in their structures, shapes, defense mechanisms, feeding habits and life cycles is the result of the process of their adapting themselves to different conditions and environments. It is this adaptability that defines the biodiversity of an area.



Diversity in Rice

Species Diversity

- **Species** diversity refers to the variety of life forms present on the Earth.
- Each species of a living organism is different from the other species e.g. butterflies and moths are a different species than lions and tigers.
- Species diversity is usually the total number of different species found in an area, be it a forest or a pond.

Genetic Diversity

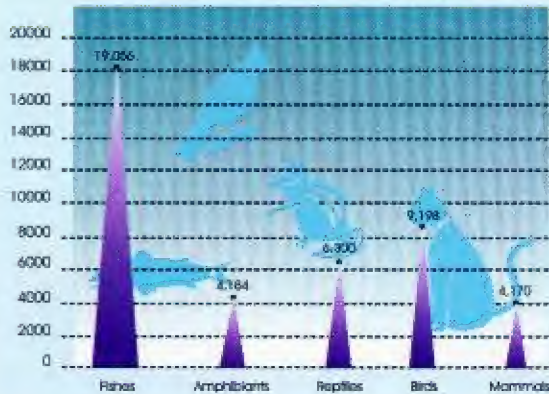
- Genetic diversity refers to the variation of **genes** and **genotypes** between and within the species.
- Genetic biodiversity results in variation within a particular species e.g. rice colour, which varies from white to red, from brown to black. We can also perceive diversity in taste, odour, and size of the grain as a result of genetic diversity in rice.
- The uniqueness of **endemic** species also contributes to genetic diversity. These species are limited to a specific geographical area (e.g. the *black buck*). They have evolved to adapt to the special conditions in the area they inhabit today. If their **habitat** is destroyed, for instance by destruction of grasslands and **scrub forest** there is the probability of them becoming **extinct**.

He that plants trees loves others besides himself
Thomas Fuller

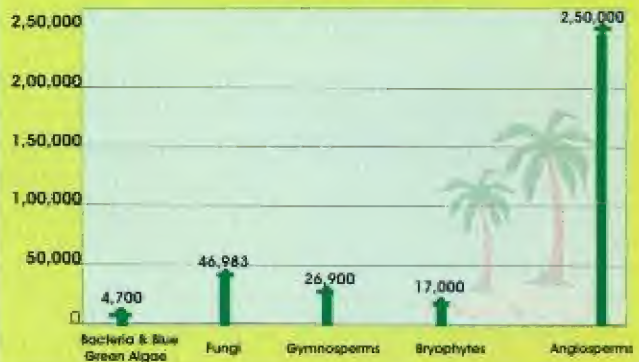


Biodiversity

Vertebrate Diversity



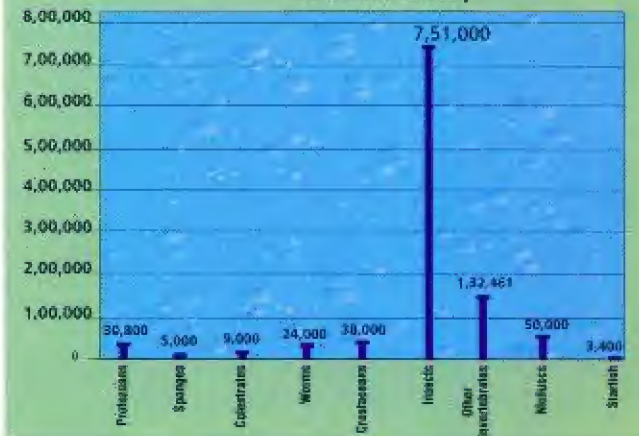
Plant Diversity



Ecosystem Diversity

- An ecosystem is a group of living things such as plants, animals and micro-organisms who interact with one another and as well as with the non-living elements such as air, water, soil and minerals of their environment.
- It includes major natural systems such as grasslands, **mangroves**, **coral reefs**, **wetlands** and tropical forests etc. Thus, ecosystem diversity is the diversity of habitats with different living organisms inhabiting it, found within a state or a country or any political boundary.
- It can also be referred to as the variety of species or abundance of species within an ecosystem, so the greater the variety of species, the more diverse the ecosystem is considered to be.

Invertebrate Diversity



Domesticated Diversity



Domesticated Sheep

- Domesticated biodiversity is the result of **manipulation** of genes by humans within a species to produce new varieties of crops and new breeds of domestic animals. It also includes **adaptation** of crops and domestic animals to different climatic and geographical conditions.
- The ancient practice of domesticating animals has resulted in India's diverse livestock, poultry and other animal breeds.
- India's eight breeds of buffaloes represent the entire range of domesticated biodiversity of buffaloes in the world.

Micro-organism Diversity

- Just a teaspoonful of soil contains billions of these microscopic living organisms! Microbes include bacteria, virus, protozoa, yeast, fungus, and constitute a vital part of earth's life forms.
- Microbes play an important role in the recycling of natural components. They live in the digestive tracts of most animals, including humans and insects, where they break down food and facilitate digestion.
- Microbes in the roots of **leguminous** plants transform atmospheric nitrogen and make it available to the plants.
- The soil contains thousands of species of microbes, which decompose dead organic matter and help maintain soil structure.
- Some microbes make enzymes. While most microbes are useful, some can also be deadly, causing diseases among plants, animals and humans.



Microbes



What are Megadiverse Nations?

- Biodiversity is not evenly distributed among the world's countries.
- Barely a dozen countries, lying partly or entirely in the tropics, account for 60 to 70% of the world's biodiversity. They are referred to as Megadiverse Nations. Species richness is high in the tropics and the cold depths of the oceans as both these regions are somewhat protected from disturbances due to inaccessibility.
- The 12 megadiverse nations include Brazil, Colombia, Ecuador, Peru, Mexico, Zaire, Madagascar, Australia, China, India, Indonesia and Malaysia.

What are Biodiversity hotspots?

- British ecologist, Norman Myers, defined the biodiversity hotspot concept in 1988.
- Biodiversity hotspots are regions that harbour a great diversity of endemic species and at the same time, have been significantly impacted and altered by human activities.
- To qualify as a hotspot a region must support 1,500 endemic plant species or 0.5% of the global total and must have lost more than 70% of its original habitat.
- There are 25 biodiversity hotspots. These hotspots contain 44% of all plant species and 35% of all terrestrial vertebrate species in only 1.4% of the planet's land area. In India, there are two hot spots. Northeast Himalayan Range and Western Ghats.

Biodiversity

Highlights of Indian Biodiversity

Wonders of Nature

India is the only country where all three big cats, lion, tiger and leopard are found.

The Blue whale is the biggest mammal. It's as long as eight elephants in a row.

The smallest wild cat is the rusty spotted cat of India. It usually weighs less than 1.5 kg.

The nilgai is the largest antelope in the world while the four-horned antelope is the smallest one.

The Sarus Crane is the tallest flying bird of India and world.

The only snake in the world which makes a nest to lay eggs is the King Cobra found in India.

Of the 8 species of marine turtles found in the world, India is home to five and all are endangered.

Fossil records of the Himalayas show that many animals which at present do not belong to India, lived here during earlier times. Animals such as giraffes, hippopotamus, chimpanzees, orangutans, and baboons which are foreign to us roamed on our land long ago.

The world's best sandalwood grows in the Marayoor belt of Kerala.

Wild relatives of rice, finger millet, pearl millet, sugarcane, pepper, turmeric, ginger and nutmeg are found in the Western Ghats.

The oldest tree of the country is a Shaitoot tree at Joshimath in the Chamoli District of Uttar Pradesh believed to be about 12,000 years old. Another is the deodar tree at Balcha, Garhwal said to be 704 years old.

A banyan tree in the Anantapur district of Andhra Pradesh, has the largest canopy. The tree covers an area of 5.2 acres and is believed to be over 600 years old.

The majestic deodar found in Jammu and Kashmir and Himachal Pradesh have trunks measuring a record 12 m (39.36 ft.) or more.

The ebony tree, which has the blackest wood, is found in Andhra Pradesh, Tamil Nadu, Madhya Pradesh, Maharashtra, Orissa and Karnataka.

The tallest bamboo found in Assam and Bengal grows to a height of 30.4 to 36.5 m. with a diameter of 20-25 cm. The bamboo flowers only once in its lifetime every 15, 30, 60 or 120 years after which it dies.

The elephant creeper (*Entada pursaetha*) can grow to a length of 1.5 km, making it one of the longest in the world. It has enormous bean-shaped pods over 1.5 m and 10 cm wide containing chocolate-coloured seeds. It grows in the Eastern Himalayas and in the Western Ghats of India.

The Arabian Sea, the western waterfront of the Indian sub-continent, supports a diverse ecosystem and biota. Some 624 species of plants and 12,000 species of marine fauna are found in these waters.

Case 1: Wetlands

India has a rich variety of wetland habitats. They are the interface between land and water systems. The wetlands are natural or artificial areas of marsh or water, and can be flowing or static. Wetlands include lakes, ponds, mangroves, swamps, marshes and coral reefs.

These areas are formed by the presence of water and special environmental conditions that exist as a result of this inundation.

Wetlands are distributed throughout the country and occupy 58.2 millions hectares of the country's land. Some of the threatened wetlands are Chilka Lake (Orissa), Loktak Lake (Manipur), Wular Lake (Jammu and Kashmir), Harike Lake (Punjab), Keoladeo National Park (Rajasthan) and Sambhar Lake (Rajasthan).

The Keoladeo National Park has been popular for the migratory Siberian Cranes but in the last decade the population declined drastically and presently there are few Siberian Cranes visiting the park.



Siberian Cranes

Ramsar Sites

- To determine wetlands of International importance the Ramsar Convention was set up in 1971. India has been a contracting party to the Ramsar Convention since 1st February 1982. The criteria for having a wetland under the Ramsar Convention are as follows:
 - If that wetland supports more than 20,000 waterfowls.
 - If it supports a substantial number of individuals from particular groups of waterfowl.
 - If it regularly supports 1% of individuals in a population of one species or sub-species.



Biodiversity



How rich is the Biodiversity of Maharashtra?



Fact File

Geographical area	3769 sq.km
Area under forest cover (15%)	Recorded: 63842 sq.km, Actual: 46163 sq.km
Decrease in forest cover	2051 sq.km every year
No. of forest types	5
No. of national parks and wildlife sanctuaries	5 and 35
State representatives:	State animal: Giant squirrel State bird :Green pigeon State flower: Queen's flower State fruit : Mango

- Maharashtra's varied habitat includes Western Ghats, Satpura Range, Grasslands and Coastal Shoreline.
- Western Ghats in Maharashtra are known as the Sahyadris. They cover about 52,000 sq. km., ranging in altitude from 20 to 2,000 m. above sea level. From north to south, the ghats span 750 km. with an average breadth of 80 km. Twenty-one percent of this area is managed by the forest department, of which Sanctuaries or National Parks protect 25 percent.
- Satpura Range: These ranges which runs east to west, north of the Sahyadris, has mainly dry and deciduous types of forests, with a mixture of various types of habitats including open, dense and riparian forests, small reservoirs and patchy grasslands. It has a wide altitudinal variation from 350 to 1,200 m above sea level. The Forest Owlet, which was believed to be extinct, was rediscovered here in 1997 after 113 years. Some of the mammals recorded here are the leopard, sloth bear, four-horned antelope, striped hyena and jungle cat.
- Grasslands: An important habitat for wildlife, have often been treated as wastelands. As a result, they have been converted to agricultural lands, or have succumbed to cattle grazing or urbanization. The few fragments of grasslands that still exist in Maharashtra are home to the highly endangered Great Indian Bustard , Lesser and Greater Floricans in Nanaj Wildlife Sanctuary.
- Konkan Coastline: It varies from rugged, rocky shores to sandy beaches, to mangroves. In many places like Phansad, in Alibag District, coastal woodlands abound near the sea.
- These diverse habitats serve as homes to a wide variety life forms such as tiger, leopard , gaur, nilgai, sambar, chital, giant squirrel, sloth bear, four horned antelope and barking deer are some of the large mammals commonly found in the protected areas of Maharashtra. There are more types of birds than mammals in Maharashtra, like the bulbul, shama, cuckoo, parakeet, drongos, green pigeon, wagtails, flycatchers, sunbirds, grey jungle fowl, great Indian bustard and above all the beautiful peacock.



Biodiversity

Economic values

- Each species has potential value to human beings, as do healthy ecosystems.
- In our day-to-day life, we depend, wholly or partially, on the surrounding natural resources for our daily needs of food, shelter, clothing, household goods, medicines, fertilizer, and entertainment, besides the basic supply of air and water for our existence. Most of our food crops and medicines are derived from the gene bank of wild species. Additionally, the wonderful and diverse wildlife of our country helps in generating revenue through eco-tourism.



Aesthetic and Ethical values

- Biodiversity in India, particularly, is important for its religious, spiritual and other traditional purposes.
- Various plants and animals have ritual significance and are considered sacred on account of their association with different deities.
- Reverence and care for nature has been an integral part of our history. Emperor Ashoka set up hospitals and reserves for wild animals and birds, as is evident from the text of one of his pillar edicts.



Is our biodiversity safe?

Human activities have been resulting in the loss of biodiversity in the many ways listed below.

- **Loss of Forest Cover:** Ideally, in India, the land under forest cover should be a minimum 33%, but satellite data indicates that India's forest cover is between 12-19% of the total land area. Large areas rich in biodiversity have been reduced to small pockets. Such degradation of forests and unique habitats snatches away the abode of countless organisms.
- **Man-made Forest Fires:** Most forest fires are caused by human carelessness. These fires wipe out the homes of insects, birds, reptiles and mammals who take shelter in trees and shrubs. Also, by burning down the complete foliage, herbivores are deprived of their food. The carbon dioxide given off by the fires adds to the green house effect.
- **Agricultural Expansion:** Clearing of forests for cultivation has posed a serious threat to India's biodiversity. According to the Forest Survey of India (1987), over 26,200 sq.km of forest was converted for agricultural purposes all over India between 1951 and 1980.



- **Illegal Logging:** In spite of strict laws against illegal cutting of trees, dense forests have been reduced by those who continue to break the laws and who find it easy to access the forest for free firewood to use as fuel.
- **Mining:** Many pristine forests in the Western Ghats have been desecrated by leasing land to mining companies who bring great pressure upon the government to denotify areas within National Parks. One such example is the Kudremukh National Park in Karnataka. In spite of a great deal of opposition, an iron ore mining company was granted permission to mine.

Case 3: Biodiversity in Business

Many plants of medicinal value are being injudiciously collected from the wild, resulting in their extinction.

- **Safed Musli or *Chlorophytum borivillianum*:** It possesses unique medicinal properties and is claimed to be a natural energy tonic. It is being used increasingly in ayurvedic preparations and being sourced by pharmaceutical companies all over the world, making it a billion dollar industry. The Gulf countries, Europe and USA are major importers of the dry roots of this plant. Of the available quantum, 95% of it is from wild harvesting.
- **Sarpagandha or *Rauwolfia serpentina*:** In traditional medication the roots of this plant are used to treat high blood pressure and intestinal disorders. With its acceptance in the allopathic system the demand for it has increased vastly. Though considered 'endangered' by the World Conservation Union, it is nonetheless being over-harvested because of its medicinal properties.
- In India there are 7000 medicinal plants that are being actively used. Ninety-five percent of these are collected from the wild. The country's booming export trade in medicinal plants has risen three-fold in the past decade. As a result, 120 species have become rare or endangered.



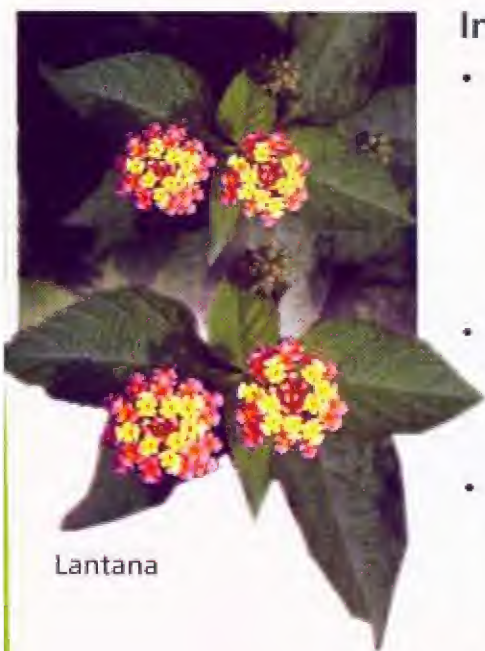
Changing Agricultural Practices

- **Monoculture** is a new trend in agriculture today. Instead of the traditional practice of cultivating a diversity of crops, only single, high-yielding crops are being cultivated. This not only drains the soil of its nutrients, but also makes the entire crop much more vulnerable to disease or pest infestation e.g. teak and sal plantations.
- The Forest Development Corporation of Maharashtra also promotes monoculture by cutting trees in forests outside national parks and sanctuaries and planting a monoculture of teak, eucalyptus or Australian acacia trees. This adversely affects the rich biodiversity of natural mixed forests and **wildlife corridors**.
- In recent times, there has been indiscriminate cultivation of a hybrid variety of cotton called Bt- (*Bacillus thuringiensis*) resistant cotton. This strain is supposed to contain a particular gene (cry1Ac) imported from the United States that confers disease-resistance from bollworms to the crop. However, monoculture of this variety of cotton, generation after generation, could lead to the bollworm getting adapted to the toxin in the plant. This in turn is bound to lead to great economic loss.

Biodiversity

Wildlife decimation

- **Poaching and Wildlife Trade:** The increasing demand for wildlife products in international markets is severely threatening certain animals and plants in our country. Wildlife trade is illegal in most countries today, second only in position to the narcotics trade in the world's black-market. Most of the animals and plants are poached for making ornamental articles, for medicinal purposes, manufacture of leather articles, for use in exotic cuisines, as pets or are hunted down just for sport. Despite severe laws and penalties, such illegal operations still prevail in our country.
- **Hunting for Sport:** In olden times, most of the abundant wildlife was hunted for sport and their numbers plummeted drastically. Today, the cheetah is extinct and the survival of wild tigers is in jeopardy. Though hunting of any wildlife for sport is now illegal, it is still carried on surreptitiously.
- **Indiscriminate collection of wild plants:** Today, arbitrary picking of medicinal plants, for indigenous therapy by pharmaceutical companies has led to a decline in the population of many precious wild varieties.



Lantana

Invasive species

- Introduction of non-native species or exotic species, deliberately or accidentally, has been a major threat to biological diversity worldwide. These introduced species flourish well in non-native areas at the cost of local species present in that area. This practice could even upset the balance of the food chain already existing amongst the indigenous species. India's biodiversity has also been affected by the introduction of alien species.
- The eucalyptus tree, native to Australia, was introduced in India because of its beauty and the oil it yields. Lack of local pests or insects feeding on it have led to its unhindered **proliferation**. Eucalyptus plantation leads to steady depletion of the ground water table.
- The Congress weed (*Parthenium hysterophorus*) was unknowingly introduced into India. It is an **herbaceous** annual and a single large plant can produce 25,000 seeds. Not only does it affect the indigenous biodiversity by competing for resources with local flora but it also causes asthma, bronchitis and dermatitis.
- The Lantana plant (*Lantana camra*) a native of tropical and sub-tropical America was introduced to India as an ornamental plant, but is now become a flourishing and potential weed. Studies show that floral diversity reduces in areas that are dominated by lantanas.



- Water Hyacinth (*Eichhornia crassipes*) is an aquatic plant that has invaded many of the fresh water bodies in India. When water hyacinth populations take over a body of water, they cover the entire water surface; the vegetation below the surface is shaded and starts decaying. This leads to a loss of oxygen in the water body. Water plants growing inside the water body, fishes feeding on mosquito larvae and other aquatic life forms suffocate and die. Thus mosquitoes flourish leading to dengue and malarial fever.



Genetic Manipulation

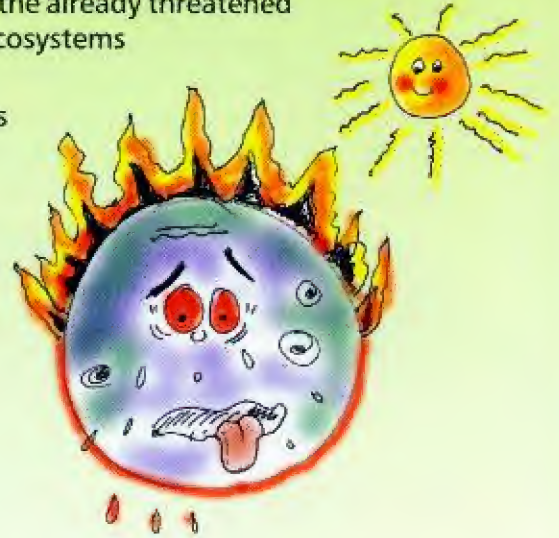
- Gene modification (GM) is the single most potent technology the world has ever known even more powerful than atomic energy. It enables us to create modifications in the genes of an organism, as per our desire and allows the patenting of life forms for commercialization. This technology is lately being used to develop crops that give better yield and long self-life.
- Undoubtedly, genetically modified crops have the advantages of low calories, better appearance, resistance to pests, longer self life, higher yields and so on. However, these are all short term benefits that go hand in hand with many long term hazards.
- As farmers go in for the GM crops or seeds that are available in the market, they no longer follow the trend of preserving seeds from the previous batch of harvested crops. This leads to extinction of seed varieties
- Genetically modified crops do not have resistance to a wide range of pests and weeds. These pests and weeds slowly adapt and turn into super-weeds and super-pests which grow well in association with the GM crops. The super-weeds and super-pests can attack the natural variety of crops and destroy entire fields.
- Terminator crop technology, involves production of GM crops that cannot be further propagated by the farmer himself. These crops die out after one yield. Thus the farmers are forced to buy seeds or saplings for their next batch of crops. This makes them dependent on the product, for which they have to spend huge amounts of money.
- GM crops are deficit in many properties that are present in their wild variety. Thus, many insects and birds that flourish in association with the wild variety are directly or indirectly affected when the wild varieties are replaced by genetically modified ones. This in turn affects the food web resulting in ecological imbalance.
- Other than the effects on the environment and its components, allergic reaction to GM food, infectious diseases that may occur due to release of interior toxins by the modified food crop and an increase in the rate of cancer cases are some of the direct effects on humans.

Biodiversity

Pollution and Global Warming

- The pollution of air, water and land is further threatening the already threatened flora and fauna. Pollution affects the functioning of the ecosystems in which the plants and animals survive.
- Certain air pollutants hinder the normal growth of plants and animals. The pesticides and insecticides used in farms and orchards have an adverse effect on animals.
- Many complex manufactured chemicals, including plastics and some metals, cannot be broken down by decomposers, permanently locking away the natural resources that went into making them.
- It is evident from scientific research that air pollutants form a layer of gas above the atmosphere and do not allow the Earth's heat, produced by solar radiation, to escape into space. Therefore, the temperature of the earth is increasing year by year and many species that cannot adjust to warmer temperatures are likely to face extinction.

(Read more about implications of air pollution on animal and plant life in the preceding chapter on Air).



Mr Scientist, can I tell you some medicinal secrets of these wild plants ?

Loss of traditional knowledge

- The tribals - our **indigenous** races - who have been living and sustaining themselves for years in a particular area, have valuable knowledge about the local flora and fauna which they pass on from generation to generation.
- However, today, the cities are luring them and many are changing their lifestyles. They seek different occupations in the hope of earning more money, and the **traditional knowledge** of which they are **repositories** is, if unrecorded, lost forever.

(Read more in the chapter on People)

Unplanned Development

- Large-scale development projects, such as construction of dams, mining, quarrying and creation of express highways have disastrous effects on the populations and natural habitats of innumerable species prevalent in those areas. It is imperative that proper planning and environment impact assessment of these areas be undertaken before any development activity is granted permission.

(Read more in the chapter on People)

Unsustainable Natural Resource Consumption

- The current world population is more than 6 billion and will probably double in the next 50 years. India's population has already crossed the 1 billion mark and could reach to 1.4 billion by the year 2025.
- Over-population leads to over-consumption of natural resources, such as water, forest products and minerals, which in turn leads to depletion of natural resources.
- In addition to rapid population growth, change in consumption patterns all over the world is causing loss of biodiversity.
- This could, in time, result in extinction of resources. Man will then have to face greater calamities such as outbreaks of dangerous diseases, droughts and famines, desertification of landmass, exceedingly high atmospheric temperatures and deficiency of water and fresh air.

(Read more in the chapter on People)



Pink-headed duck

What are the repercussions ?

- Extinction of species has been taking place for millions of years, long before the emergence of man. It is a natural phenomenon in the evolution of living organisms.
- Primitive man lived in harmony with nature and did not cause the extinction of species. But over the years, hunting, deforestation, pollution, population explosion - all these have been responsible for the extinction of many species of both plants and animals.
- Since the seventeenth century, about 120 mammals and 150 birds have become extinct in the world. The rate of extinction due to human interference has accelerated since the past century.
- In India, the cheetah, the lesser one-horned rhinoceros, the pink-headed duck, and the mountain quail became extinct in the 20th century.

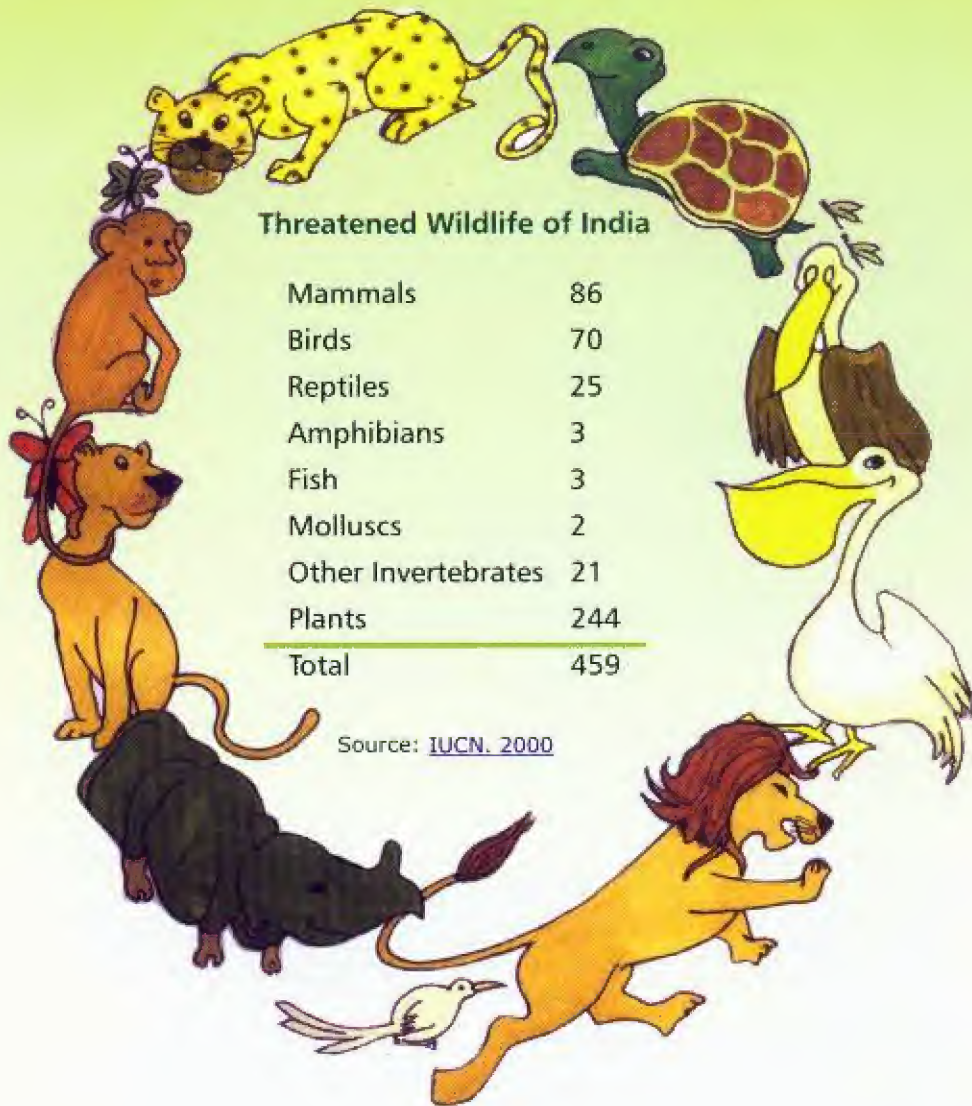
Threatened flora and fauna

- The disappearance of many species in the recent past has largely been due to man's destructive activities. Human impact on the environment has led to the recent extinction of many species and put many others on the 'waiting list'. These members of the 'waiting list' are all endangered species and will become extinct if immediate protection is not given to them.
- The Asiatic Lion is on the brink of extinction and so are the Asiatic Elephant and One- Horned Rhino. Even lesser known species such as Asiatic Wild Ass, Slender Loris, Pygmy Hog, Hoolock Gibbon, Gaur, Asiatic Wild Buffaloes, animals such as the Mountain Goat, Clouded Leopard and the Red Panda from Himalayan region and many more are critically endangered.
- Several Indian birds are threatened with extinction, such as Western Tragopan, Siberian Crane, Jerdon's Courser, Black Necked Crane, Sarus Crane, Malabar Pied Hornbills, White backed vulture, the Great Indian Bustard, the Monal Pheasant and others.
- The fate of reptiles is virtually unknown. Most of the reptiles from gharials to pythons and to turtles are in danger.
- Threatened flora such as ladies slipper orchids, flytraps, Kutki, Indian Serpent Root, Glory Lily are endangered due to commercial exploitation of these plants.
- All endangered flora and fauna of the world is documented in the Red Data Book published by WCU (World Conservation Union).



Western flytrap

Biodiversity



Threatened Wildlife of India

Mammals	86
Birds	70
Reptiles	25
Amphibians	3
Fish	3
Molluscs	2
Other Invertebrates	21
Plants	244
Total	459

Source: [IUCN, 2000](#)



Case 4: Rare and Endemic to Maharashtra

Dazelle's Frerea (*Frerea indica*) is rare, **endangered** and endemic plant, originally found by Dalzell on a hill near Junnar in the Poona district where now it survives in very limited number. It has not been seen in other similar habitats in the adjoining hilly areas which are being denuded and eroded. The species grows on exposed bare rocks of hill slopes and cliffs. The flowers are showy purplish starry and succulent having pale-yellow spots on petals. It flowers during September- October.

Besides being endemic and rare, it has also been declared as one of the world's 12 endangered species listed by the WCU. Collection and export is banned. Though the habitat of the species is incidentally free from any threats as the Purandhare Hill fort is a prohibited area for civilians. But exceptional care should be taken to ensure continual care and protection of the habitat and population within the Fort area. Attempts to cultivate it in controlled conditions are underway and final reintroduction of this species back to its original habitats are planned.

How to conserve our Biodiversity

- Biodiversity is our national heritage, each of us should cherish and protect it as we cherish our national manmade heritages.
- It is necessary to know and understand that nature with its beautiful and diverse life forms would not survive without our help. So, what are the conservation efforts undertaken by people till now? Are there any governmental or non-governmental bodies working for the cause? Let us have an insight into what has been done to conserve our biodiversity.
- Several measures have been taken, and continue to be taken, at the national level to protect biodiversity. These include:



Legislation

India has several acts in force for conservation of biodiversity. Some of these Acts are:

- Environment Protection Act, 1986: This act relates to general measures to protect the environment, such as restriction on industrial and other processes or activities in specified areas. It also deals with prevention of, and control over, the manufacture, use, release and movement of hazardous substances.
- Forest Act, 1927: This act deals with the setting up and management of reserved, protected and village forests, and controls the movement of forest produce.
- Wildlife (Protection) Act, 1972, and Wildlife (Protection) Amendment Act, 1991: This act deals with the restriction and prohibition of hunting of animals, and with the protection of specified plants. It also deals with the setting up and management of sanctuaries and national parks, setting up of the Zoos Authority, control of zoos and captive breeding. The act also controls trade and commerce in wild animals, animal articles and trophies.



In-Situ and Ex-Situ Conservation

- India has been carrying on in-situ conservation, i.e. conservation in the natural habitat since a long time, by establishing protected areas throughout the country.
- Today, India has about 87 national parks and 488 wildlife sanctuaries. National parks are legally granted a high degree of protection. No human habitation, private land holding or traditional human activity such as firewood collection or grazing is allowed within the park.
- The ex-situ conservation of plants and animals, i.e. preserving them away from their natural habitat, is being carried out in several kinds of institutions such as zoological parks, botanical gardens, forestry institutions and agricultural research centres.

Biodiversity

Case 5: Special missions

Several projects have been launched in the country to save specific faunal species in their natural habitats.

The best known of them all is Project Tiger, which was initiated in 1973. It was based on the philosophy that the tiger, being at the apex of the food pyramid, acts as an indicator of the health of the entire ecosystem. The tiger eats other carnivorous animals and herbivores and the herbivores eat plants. Thus, if the tiger is healthy, so must be all other animals and plants down the successive levels of the food pyramid in a given ecosystem. The project started with the protection of nine tiger reserves located in different types of habitats. Today, there are 23 tiger reserves under Project Tiger.

Other projects launched in India to save particular species are the Gir Lion Sanctuary Project in Gujarat, Crocodile Breeding Project in Chennai, Project Hangul in Kashmir, Conservation of the Himalayan Musk Deer, Manipur Brow-Antlered Deer Project, Project Elephant and Project Kachyap (Turtles) in Assam. Conservation projects have also been launched to save several bird species such as the Bustard, Florican, Vultures, Sarus Crane and Siberian Crane.

Conservation by Non-Government Organizations (NGOs)

- Many large and small NGO's are working for the cause of conservation in India. The oldest amongst the NGO's working for nature conservation in India is the BNHS-India (Bombay Natural History Society), established in the year 1883. The Society has been engaged in the study and research of the natural history of the Indian subcontinent since its inception.
- Similarly, the World Wide Fund for Nature-India (WWF) was established in 1969 in India to promote India's ecological security and restore the ecological balance.
- Besides these organizations, there are many local NGO's active in various regions in India such as Kalpavriksha in Pune and Delhi, Bombay Environment Action Group in Mumbai, Tarun Bharat Sang in Rajasthan among others.

Can we make a difference?

We may not all have the power to enact sweeping reforms of environmental legislation, but we do have the power to contribute to biodiversity conservation, each and every day. Here are few tips for you to follow:



- 🐾 Plant trees, shrubs and creepers that are indigenous to our soil, thereby making habitats for local birds, bees, butterflies and squirrels.
- 🐾 Avoid usage of pesticides in your gardens and allow the web of life to prosper.
- 🐾 Prevent trees from being cut. Inform concerned authorities, immediately!
- 🐾 Don't waste paper. Use unused side of paper for rough work; reuse envelopes, cartons, and gift-wrapping paper; donate or purchase second-hand books, rather than always purchasing new ones.
- 🐾 Gift a sapling instead of a bouquet on birthdays and anniversaries.
- 🐾 Don't catch, kill, or tease small animals and insects like birds, monkeys, butterflies, or dragonflies even when you go to the zoo!
- 🐾 Avoid buying, gifting or using animal products. Never buy, gift or use endangered-animal products. When the buying stops the killing will stop too.
- 🐾 Don't disturb or destroy animal homes such as nests, anthills and beehives.
- 🐾 Learn more about your local flora and fauna.
- 🐾 Involve yourself and your friends in wildlife activities, such as joining wildlife-promoting organizations like the World Wide Fund for Nature-India and the BNHS - India.
- 🐾 Volunteer for an environmental cause such as Save Mangroves, Save the Tiger and so on.
- 🐾 Plan your vacation in a national park or sanctuary, or nearby nature enclave.



Biodiversity

Glossary

Adapt

(**adapting, adaptation**): To change to suit different conditions and environment

Coral reef: Marine ridge formed of compact coral together with algal material and biochemically deposited magnesium and calcium carbonates.

Endangered: Species that are in danger of being extinct in the immediate future

Endemic: Species limited to a specific geographical area.

Extinct: Not in existence.

Habitat: Natural conditions and environment in which plants and animals live.

Herbaceous: Herbs

Indigenous: Belonging to the place of its origin.

Leguminous plants: Plants that have pods that split into two valves.

Mammals: Animals having hair on the body and females having mammary glands

Mangroves: Salt tolerant tropical evergreen trees or shrubs having stilt like roots and stem and forming dense thickets along tidal shores.

Manipulation: The act of arranging or controlling by the hands or by mechanical means

National Park: a protected area declared by Central Legislation, enjoying the highest level of protection with a vision to safeguard it for the enjoyment of future generations.

Poaching: Hunting/killing of wildlife.

Repositories: Places in which something is stored.

Reservoirs: natural or artificial ponds or lakes used for storage and regulation of water supply

Sanctuary: area which has been declared as protected due to some rare wildlife found therein. Human activities such as livestock grazing, collection of forest produce and tourism are allowed with the supervision of the head of the Forest Department.

Scrub forest: Desert like landscape with a few thorny shrubs and few water bodies.

Species: An organism belonging to a category of classification consisting of related organisms capable of interbreeding

Traditional knowledge: Knowledge of tribals that comes from practical living passed on from generations.

Wetlands: Lowland areas, such as marshes or swamps, which are saturated with moisture.

Wildlife decimation: Destruction, removal or damage to wildlife.

Wildlife corridors: Connecting Pathways within forested areas for wildlife movements.





ACTIVITIES

ACTIVITY 1: Is your school environment friendly?

Objective: To create awareness on environment friendly lifestyles.

Background: Share the tips on biodiversity conservation.

Subjects covered: Science and Mathematics.

Approach: Observation and Survey.

Materials required: Data sheet and pen/pencil.

Method:

1. Divide the class into four groups.
2. Handout each group the datasheet given below and assign 1-5 questions of the datasheet to group 1, 6-10 to group 2, 11-15 to group 3 and lastly 16-20 to group 4.
3. Ask the individual groups to find out the answers for their questions by going in and around their school.
4. Give the groups two days to collect the data.
5. When children are ready with their data, pool all the data and give 1 point for every positive answer and add them and judge as per the grades given below.
6. Discuss the possibility of converting negative answers into positive ones. Encourage children to carry out similar activities for their homes and localities.

Next to each question, put a tick for 'Yes' and a cross for 'No'.

	Yes	No
1. Does the school have a garden?	<input type="checkbox"/>	<input type="checkbox"/>
2. Is the garden waste used to prepare compost?	<input type="checkbox"/>	<input type="checkbox"/>
3. Is old paper reused (like empty pages in the notebooks of the previous years or computer paper) as rough paper?	<input type="checkbox"/>	<input type="checkbox"/>
4. Are solar powered calculators used?	<input type="checkbox"/>	<input type="checkbox"/>
5. Are lights switched off when not needed?	<input type="checkbox"/>	<input type="checkbox"/>
6. Are leaking taps repaired immediately?	<input type="checkbox"/>	<input type="checkbox"/>
7. Do students and teachers use cloth bags instead of plastic bags?	<input type="checkbox"/>	<input type="checkbox"/>
8. Is any waste collected for recycling?	<input type="checkbox"/>	<input type="checkbox"/>
9. Is the noise level in the school within the permissible limits?	<input type="checkbox"/>	<input type="checkbox"/>
10. Does the school library provide books on environmental issues, nature or wildlife?	<input type="checkbox"/>	<input type="checkbox"/>
11. Does the school have a Nature Club?	<input type="checkbox"/>	<input type="checkbox"/>
12. Is any nature or eco-projects carried on by the school for students and teacher	<input type="checkbox"/>	<input type="checkbox"/>
13. Does the school celebrate the environmental days?	<input type="checkbox"/>	<input type="checkbox"/>
14. Does the school participate in any environmental campaigns?	<input type="checkbox"/>	<input type="checkbox"/>

Results : Give yourself one point for every positive answer and than see for the results

20 points: Congrats the school is the no. 1 eco-friendly

Less than 20 and more than 15 point: The school is struggling to reach the no.1 position. Keep it up.

Less than 15 and more than 10 point: The school needs to push itself a bit to be comfortably eco-friendly.

Less than 10 points: The school has to really work very hard to make itself eco-friendly.





ACTIVITIES

ACTIVITY 2: How to study effects of pesticides on the environment?

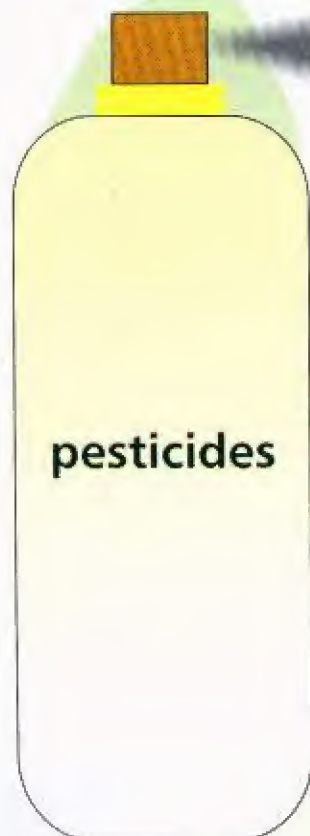
Objective: To make the students understand how chemical pesticides could cause long term harm to the habitat.

Background: The children should know the terms food chain and bio-magnification and the positive uses of alternative harmless pest control methods such as bio-controllers like ladybird beetles and praying mantids, and natural pesticides.

Subjects covered: Science.

Approach: Experiments and observations.

Materials required: Some pebbles & mud, small clay pot with a tiny aperture at the base, tray, blue ink, water, glass tumbler/beaker, long & thick stemmed white flower such as lily or tuberose.



Method:

1. Ask children to spread a layer of pebbles in the clay pot, then spread a layer of mud over them and place the clay pot on the tray and pour a small glass of blue ink into the pot.
2. The blue ink begins to seep through the soil into the tray.
3. Explain that pesticides also percolate the soil and enter ground water, eventually finding their way into lakes and rivers.
4. Add blue ink to little water and pour into the glass tumbler/beaker.
5. Place the flower upside into it.
6. Make children observe how the flower stem absorbs the water and begins to change colour, turning blue.
7. Explain to the children that chemical pesticides also behave in similar manner and get absorbed by plants, which in turn are eaten not only by insects but also by cattle whose milk is consumed by humans. Even birds that predate upon insects consuming the plants could get poisoned.
8. Hold a brainstorming session on pesticides and its effects on the natural world. Share the outcomes in the school magazine or children's newspaper.



ACTIVITIES

ACTIVITY 3: What is Ecology?

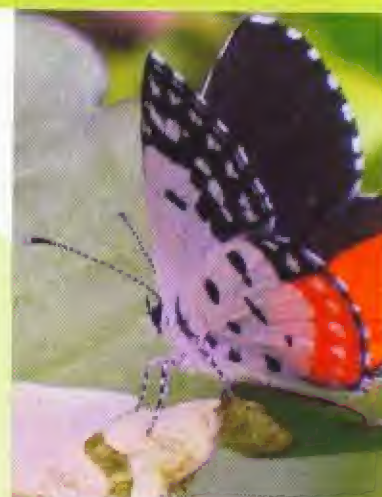
Objective: To make children realize the importance of every element in the ecosystem, interrelationship between the components, and the extent of biodiversity.

Background: Explain to the children the concept of a habitat, the biotic components and abiotic components, the role or niche of the biotic components in a particular habitat and interdependence amongst the organisms.

Subjects covered: Science.

Approach: Field study.

Materials required: Chart paper and pen/ pencil.



Method:

1. Identify and select a site for studying a particular ecosystem e.g. a garden or a park, banyan/peepal/mango tree, a fallen log of wood, a pond or stream.
2. Prepare an observation schedule (format given below) for the children to fill up regularly.

The teacher carries out a follow-up intermittently. The students analyze the findings of the observations and discuss the same in class.

Name of the habitat:	Time of day	Date:
Total area:		
Abiotic components:		
Biotic components:		
Visitors to the habitat:		
If the habitat is a tree the following details may be entered:		
Name of tree:		
Approximate height of tree:		
Girth of the trunk:		
Type of the bark:	Cracked / Flaky / Smooth	
Description of the canopy:		
Leaf	Arrangement:	Size:
Flowers:	Colour:	Size: Flowering period:
Pollinators: (insects, birds or bats)	Description of insects/birds/bats:	





ACTIVITIES

ACTIVITY 4: Can I save the Tiger?

Objective: To make the students realize the various threats to this magnificent animal, the tiger.

Background: Explain about the various threats to the tiger, and how due to these threats this animal is vanishing.

Subjects covered: Science.

Approach: Game.



Method:

- 1 Select ten children as tigers and make them wait outside the classroom.
- 2 Select another 15 children and make five groups of three children each who represent threats to the tiger. (The tigers are not supposed to know who is posing a 'threat'). The threats would be 'Poaching', 'Hunting for Sport', 'Hunting for Wildlife Trade', 'Deforestation' and 'Construction of Dams'.
- 3 Make the remaining children to form a big circle and let the 'tigers' walk around in the circle.
- 4 The children representing the 'threats' stand in circle without the tigers knowing about the 'threats'.
- 5 Call out for any threat, e.g. Poaching. The children representing the 'threat' try to catch the tigers while the latter run out of the circle. Those who are caught are considered dead while those who escape can enter the circle once again.
- 6 Repeat this activity until only one tiger is left. Call out the 'threat' and when the threat-representing group enters the circle to catch the tiger, then you intervene and stop the 'threat' and explain everyone in the circle the measures for protection of tigers.
- 7 Start the discussion on the role of people to stop the threats and save the tiger.





ACTIVITIES

Activity 5: How to develop a butterfly Garden?

Objective: To build sensitivity towards nature, a sense of caring and also to gain knowledge about plants and insects and their relationship. Plants attract butterflies and moths and it is a great joy to observe the different stages in the life cycle of the butterfly/moth.

Background: Knowledge about plant animal associations in nature.

Subject: Science.

Approach: Observation and research.

Material Required: List of food plants and nectar plants of butterflies, garden plot and gardening materials.

Method:

1. Ask children to plant food plants and nectar plants in different plots of the gardening area.
2. Ensure that plot is sunny and within the school compound or if sufficient space is not available, even pots could be used
3. When the plants have grown sufficiently, the class may be divided into groups of five and each group given a chance to tend to the garden for a week.
4. All the students should keep a watch for any new developments in the garden and report it.

Name of nectar plants for butterflies in general: Lantana, Cockscomb, Nirgudi, Marigold, Cosmos, Sadaphuli, Poinsettia, Mexican Sunflower

Name of Food plant	Name of Butterfly
Lemon tree, Curry leaves	Common Mormon & Lime butterfly
Milkweed or Rui	Plain Tiger & Common Crow
Watakaka	Blue Tiger
Bryophyllum	Pierrot
Portulaca	Danaid Eggfly & Great Eggfly
Sontaka	Grass demon
Bitter hedge	Silverline
Ixora	Monkey puzzle
Talimkhana	Peacock pansy, Grey pansy, chocolate pansy, Yellow pansy,
Yam	Yamfly
Mussaenda	Commander
Khair	Common Nawab



Air

Who has seen the wind? Neither you nor I: But when the trees bow down their heads the wind is passing by.

Christina G. Rossetti

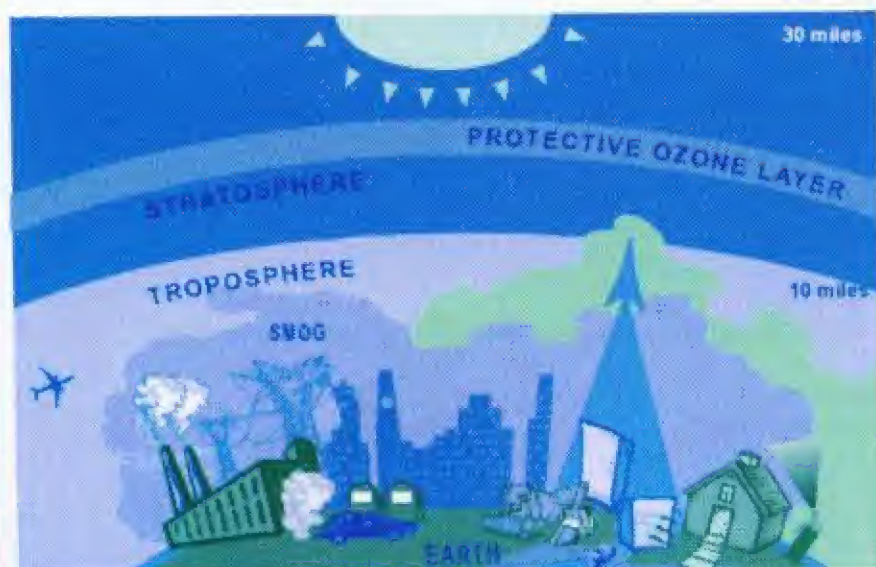
The life support systems of nature would come to a halt if plants and animals stopped respiring. This chapter deals with crucial aspects of air and its pollutants. It provides you with content and activities to help bring out a positive change among your students. Let us together thrive for cleaner air so that our future generations enjoy the luxury of breathing fresh air directly through their noses and not through masks!



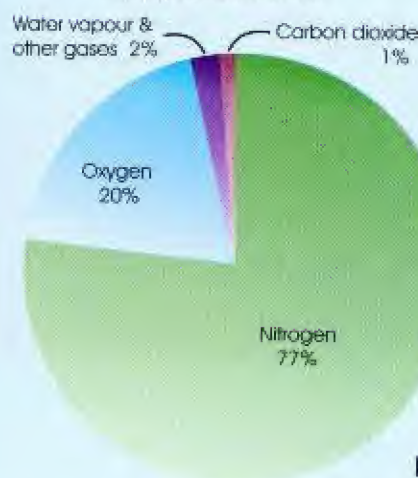
Know the air

- From the tall mountains, to the deep seas, from open farms to a tiny match box, from around the Earth to inside the body, air is everywhere.
- We inhale and exhale air every second. Can you imagine how things would be on this Earth if there was no air?
- The Earth would be a lifeless planet. Air is a precious, life-sustaining natural resource. Yet the concern for clean air and for protecting it from man-made sources of pollution, has come to our minds only recently.
- The thick blanket of air around the Earth is called atmosphere. The atmosphere is divided in

Troposphere which is mostly concentrated in the 10 km near the Earth's surface. This is followed by the stratosphere wherein the ozone layer lies. The ozone layer filters the **ultra violet** rays of the sun before they reach the Earth. Above the stratosphere is the mesosphere, and beyond this is the **thermosphere**. The thermosphere contains the ionosphere, a layer densely populated with charged particles called ions. The ions in this layer play an important role in catching and sending signals and help in telecommunication and radio communication.



Composition of Air



Focus on air pollution

- A twenty minute walk in a nearby garden, a green lane or in a forest is not at all exhausting. Instead, it makes one feel more energetic!
- In contrast, walking for even a few minutes on a road with heavy traffic or in an area near factories makes one feel tired and breathless. Why?

Because in these areas the quality of air is not at all good; it is impure or polluted. The moment one leaves one's house, one comes across the culprits of pollution: vehicles, factory chimneys, fire crackers, burning garbage on the road side.....all producing smoke that fills the air with harmful chemicals. Is there any escape? Yes! But, one must first know the sources and causes of this global problem of air pollution.



Lichen Detectors

Lichens are organisms that consist of an alga and a fungus living in a symbiotic relationship. The fungus provides structural support for the alga and improves exposure to sunlight. The alga produces food for the fungus through the process of photosynthesis. As a result of this relationship, lichens can survive in harsh environments where algae and fungi cannot live alone.

Although lichens are very hardy, they are among the first organisms to suffer from the effects of air pollution. Because lichens lack roots, they absorb rainwater directly into their cells. As a result, lichens absorb more dissolved toxic substances like sulfur-dioxide than other plants. Eventually, these toxicants build up to a level where the algae can no longer photosynthesize the sun's energy and die. The death of the alga leads to the death of fungus and the lichen as a whole.

The air quality of an area can easily be determined by observing the lichens that are growing on older trees. Generally, more the lichen, healthier the air would be. Scattered orange and gray lichens usually mean better air quality. Some areas are so polluted that no lichens can be found. These areas are called "lichen deserts". As the air quality in these lichen deserts improve, lichens slowly begin to reappear.

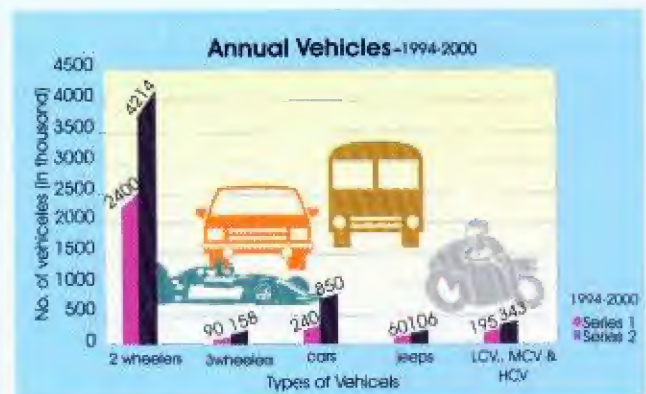
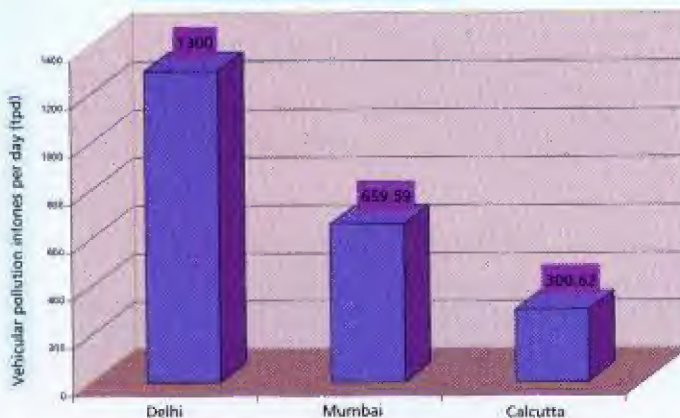


Pollution in Cities Traffic

- Traveling from home to work, going to school, heading off for a picnic, sending a bag of gifts to a relative living in another town, or just going for a drive, we all need some mode of transportation. If the transport system weakens or stops functioning, all work seems to come to a halt. Imagine what happens when our *buswallahs* or *taxiwallahs* or *auto-rickshawwallahs* go on strike?
- There are almost 3.7 million motor vehicles on the roads of India. These vehicles include buses, trucks, jeeps and cars. If we add tempos, scooters, motorbikes and auto-rickshaws the numbers become much higher.
- The fumes emitted from these vehicles include carbon monoxide, nitrogen oxides, hydrocarbons, aldehydes, lead oxides and particulates.
- While industrial air pollution is a localized source of pollution, vehicles are mobile polluting units, and bring entire cities into the grip of air pollution. India's urban centers are turning into **gas chambers**.



Vehicular pollution in 1994



Case 1: Health Issues

Carbon monoxide reduces the capacity of our blood to carry oxygen, producing a feeling of suffocation. Lead particulates that we breathe in are deposited in tissues and bones and can prove fatal over time. A survey by National Institute of Occupational Health, Ahmedabad, revealed that the blood and urine of traffic policemen and roadside shopkeepers shows higher concentrations of lead as compared to the blood and urine of unexposed persons.

Smog

- Is this word unfamiliar? One has heard about 'smoke' and 'fog'. Smoke + fog have given us the term smog.
- Smog is another kind of air pollution. It occurs when small particles or smoke released by industries and vehicles get trapped in fog. When this mixture of small particles, toxic gases and fog floats in the air, sunlight acts upon it causing a number of chemical reactions. These reactions give rise to **photochemical** smog. Photochemical smog is a noxious mixture of gasses harmful to most living organisms.

Case 2: Blurred Ludhiana

- In October 2005, farmers burning paddy stubble in Ludhiana created **perennial** smog in the city. The ongoing smog posed a serious environmental problem and health hazard. Environmentalists suspected that this problem would only be aggravated during the celebration of Diwali, with the bursting of fire crackers.
- For one week, the city witnessed smoky evenings and mornings, causing respiratory and eye ailments amongst its residents. While the smog was generally present at night, the smell of smoke remained during the day, too.
- Experts in the Meteorological Department of Punjab Agricultural University stated that the presence of fog was caused by a fall in temperature. Smoke from the burning of paddy stubble and bursting of firecrackers then mixed with the fog. The fog and smoke together resulted in the accumulation of a thick layer of smog.
- All village roads connecting to the city were under the cover of smoke. The situation in villages around city was even worse. Villagers faced poor visibility during nights while clouds of smoke were seen throughout the day.

Garbage

People residing in areas close to an open **dumping ground** are exposed to long hours of rotting garbage stink every day. Additionally, they inhale the smoke and fumes generated by the burning of huge amounts of garbage at regular intervals.





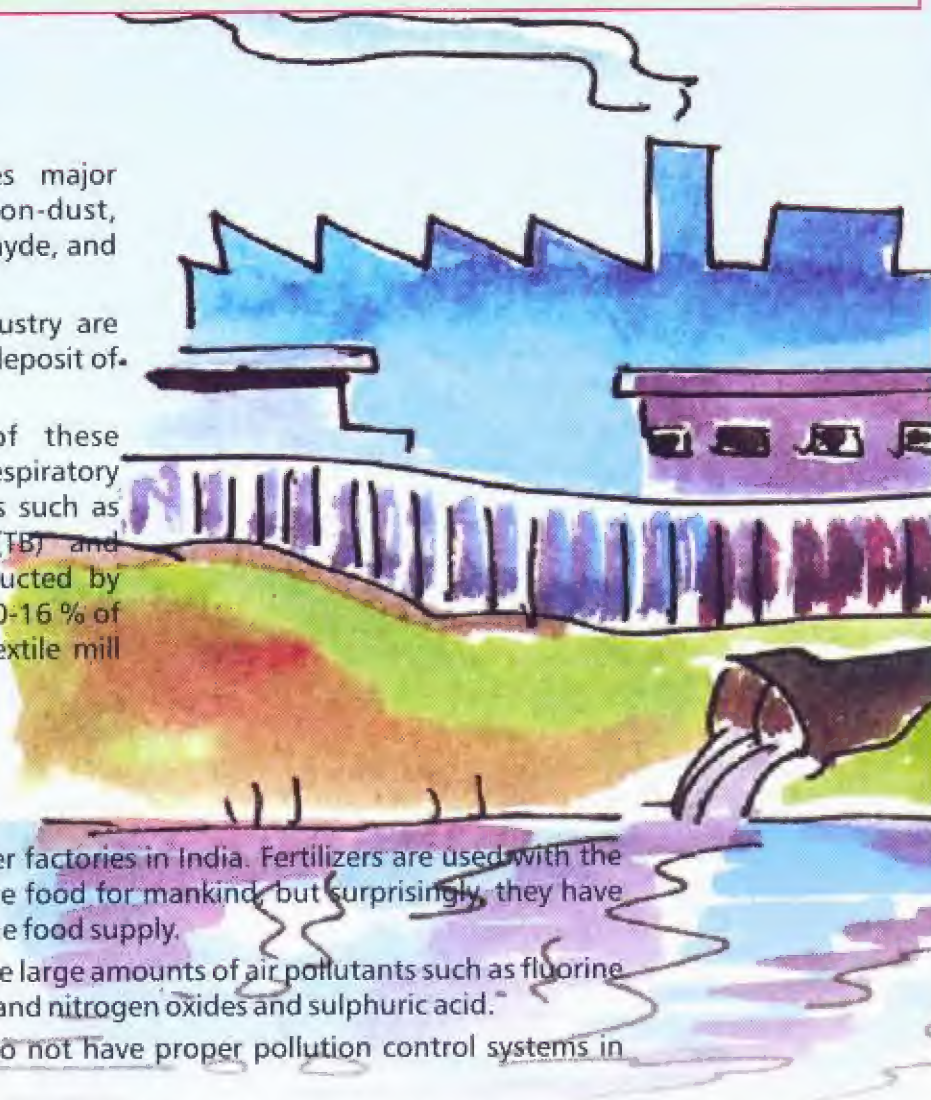
Case 3: What Rubbish!

Fumes from burning of garbage containing large amounts of plastics and other toxic material are slowly emerging as a major cause of health problems in localities close to dumping grounds in many of India's larger cities.

A 1995 study conducted in Mumbai, by King Edward Memorial (KEM) Hospital reported that, among the residents of Ghatkopar and Chembur, 66% of coughs, 55% of headaches and 71% of eye irritation cases result from exposure to fumes produced by the Deonar dumping ground. When burned by scrap dealers for metal pieces, the unsorted garbage releases lead, cadmium, mercury and many other toxic fumes.

Textile Mills

- Textile processing involves major pollutants such as cotton-dust, smoke, kerosene, formaldehyde, and chlorine dioxide.
- Areas around a textile industry are usually covered with a thin deposit of cotton fluff.
- Long term inhalation of these particles weakens the respiratory system and causes diseases such as **byssinosis**, tuberculosis (TB) and **bronchitis**. A survey conducted by KEM hospital reveals that 10-16 % of byssinosis cases occur in textile mill labourers.



Fertiliser Factories

- There are 67 large fertilizer factories in India. Fertilizers are used with the promise of providing more food for mankind, but surprisingly, they have had a negative effect on the food supply.
- Fertilizer factories generate large amounts of air pollutants such as fluorine gas, particulates, sulphur and nitrogen oxides and sulphuric acid.
- Most of these factories do not have proper pollution control systems in place.
- Air pollutants rise into the atmosphere and return to earth by getting dissolved in rainwater and then entering rivers and **aquifers**.
- When fertilizer-loaded water flows from farms to the marine coast, the high concentration of nitrogen in it kills fish.
- On land, fertilizers change soil pH and reduce soil fertility over time. Fertilizers can facilitate the growth of a large number of weeds and can also increase the risk of agricultural diseases.

Case 4: Bhopal Gas Tragedy

In 1984, an extreme crisis of air pollution from industrial pollutants was faced by Bhopal city, which suffers from the effects even today.

On the night of Dec. 2, 1984, the Union Carbide India Limited plant in Bhopal, manufacturer of a pesticide called methyl-isocyanide (MIC) accidentally released the deadly gas. Tonnes of gas leaked from a tank, killing and injuring thousands.



The figures were horrific: 1,800 persons were killed instantly and other 6, 00,000 persons continue to suffer from several chronic diseases caused by inhalation of the gas.

Uproar sounded from Bhopal and from the rest of the country, too. Activists demanded that the American company should be sued. They demanded employment for the survivors, and the clean-up of the 18,000 tones of toxic waste lying unattended in the premises of the Union Carbide factory.

Following the disaster, the Government of India passed the Bhopal Gas Leak Disaster (Processing of Claims) Act, 1985. At present, there are no international laws to deal with scenarios like the Bhopal gas tragedy. Substantive international law remains quite weak in the area of pollution, industrial hazards, and **multinational** business regulation.

Thermal Power Plants

- Life without energy would indeed be very difficult. Where does all the energy come from? In our country, most of it comes from coal. Thermal power stations use coal to make electricity. But thermal power stations also give out a lot of pollutants, like fly ash and sulphur dioxide, which pollute the air.
- The most problematic pollutant generated by thermal power plants is **fly ash**. Fly ash tends to remain in the air for a very long time. This airborne ash can cause irritation to the eyes, skin, nose, throat, and respiratory tract. Inhalation of fly ash dust over a long period of time can cause bronchitis and lung cancer.



Case 5: Black Bhatinda

The Indraprastha power plant at Bhatinda, in Punjab, gives out tonnes of fly ash every year. The electrostatic precipitator, used to clean the out-going smoke at the power plant, has broken down. Today, Bhatinda is coated with fly ash, and lies under a blanket of smoke. Thousands of acres of crops near the power plant are getting damaged. Additionally, cases of respiratory and eye disorders among residents have greatly increased in the last few years.

The power plant management is denying the pollution problems, though it plans to install a new precipitator. Is it acting very slowly?

The localities have made efforts to get help from ministers and officials but have received none so far. Currently, they are working to create a public forum.

Can you believe that this thermal plant supplies no energy to Bhatinda ?

Air

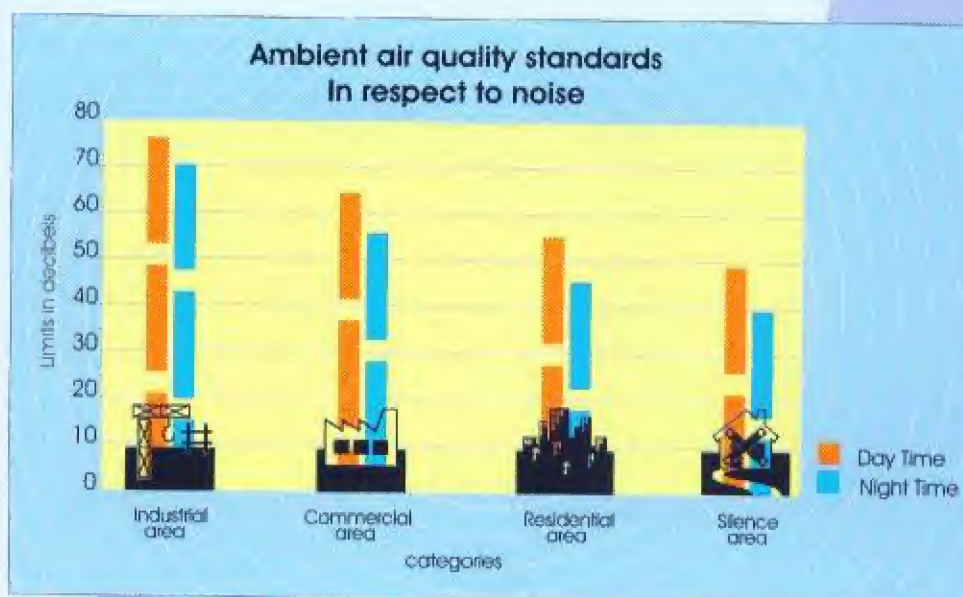
One cannot completely stop the outflow of all pollutants that occur in the process of development. However, the concentration of pollutants in the air can be controlled. It should not exceed safety standards laid down by National Ambient Air Quality Standards. Concentration above these standards threatens life and material.

Pollutants	Concentration of Ambient Air/day (in $\mu\text{g}/\text{m}^3$)		
	Industrial Area	Residential, Rural and other area	Sensitive area
Sulphur Dioxide (SO_2)	80-120	60-80	15-30
Oxides of Nitrogen (NO_2)	80-120	60-80	15-30
Suspended Particulate Matter (SPM)	360-500	140-200	70-100
Respirable Particulate Matter (size Less than $10\ \mu\text{m}$) RPM	120-150	60-100	50-75
Lead as Pb	1.0-1.5	0.75-1.0	0.5-0.75
Carbon Monoxide	5.0-10.0 mg/m^3	2.0-4.0 mg/m^3	1.0-2.0 mg/m^3

Noise pollution



- Indians are regarded amongst the noisiest people in the world. We have become deaf to the extent that noise is no more a nuisance. But it is certainly a health hazard, which, sooner or later, manifests itself in a variety of disorders.
- Noise not only causes irritation and annoyance, but also constricts the arteries, and increases the flow of **adrenaline**, forcing the heart to work faster.
- Experts believe that continuous noise levels in excess of 90 decibels can cause loss of hearing and irreversible changes in the nervous system leading to **neurosis** and nervous breakdown. Researchers also claim that if high noise levels continue to remain in our surroundings, future generations may be born with hearing problems.
- The World Health Organization [WHO] has fixed 45 decibels as the safe noise level for a city.
- However, **metropolitan** areas in India usually register an average more than 90 decibels; Mumbai is rated the third noisiest city in the world, with New Delhi following closely.
- In India loudspeakers are increasingly becoming a favorite way of expressing sentiment. Daily prayers in temples and mosques, our festivals, new-year parties, marriages, birthdays, as well as numerous other small occasions, have become perfect reasons for using loudspeakers, not just through the day, but even late into the night.



Green way to curb noise pollution !

- Avoid playing loud music both at home and a locality. Talk softly whenever possible.
- Plants decrease noise pollution by acting as sound absorbers and reduce particulate matter by trapping solid deposits in their foliage. It is therefore suggested that residential areas, educational institutions, and hospitals should be surrounded by trees.
- For a community celebration, loudspeakers should be kept under trees so that the sound does not travel far and disturb people of other localities.



Radioactive Pollution

It is no secret that **radiation** from nuclear power plants and explosives is lethal to plant and animal life. But the threat of radioactive pollution is closer home than one might think. Indoor air pollution is caused by products of daily use found in average city homes. Watches with luminous dials containing radium or tritium, TV sets, mobile phones, X-Rays, and certain other consumer articles are sources of radioactive pollution.

- The rays emitted from these appliances travel through air and penetrate the soil, water, living forms,



walls, glass etc. These radiations may penetrate living cells and cause mutations in their genes. Such mutations may further lead to cancer and other **genetic** diseases.

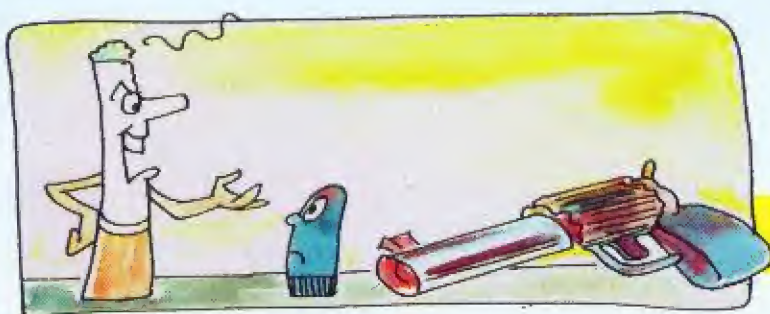
- In order to avoid these radiations ensure that one keeps a safe distance from all these appliances while in use. Minimizing the use of these items is the only way to safer health.

Air



Smoking

- Smoke from cigarettes, cigars and beedies is also a significant contributor to air pollution.
- Besides severely affecting the respiratory organs and a cause for cancer, heart disease and pneumonia among smokers, smoking is dangerous for others too. Inhalation of smoke produced by others called second-hand smoking, can lead to similar health problems.
- Smoking in public places should be avoided. Avoid from being a passive smoker by requesting the smoker to move away from you.



I kill more people than you

Other Household Pollutants

- Appliances such as refrigerators and air conditioners emit pollutants called chlorofluorocarbons (CFCs) into the air.
- The CFCs travel high up into the stratosphere and eat up ozone molecules, causing ozone layer depletion.
- Paints, aerosols, perfumes, air fresheners, solvents, glues, all contain toxic chemicals. Depending upon the amount of pollutant inhaled and duration of exposure, these pollutants may cause moderate to serious damage in humans and impair environmental health, as well.
- Always use environment friendly paints and air fresheners. Look out for the **eco-mark** on such products.



Pollution in Rural areas

- Atmospheric pollution was long considered to be concentrated only in major cities. However, recent studies have demonstrated that air pollution is a significant problem in the villages of India too.
- Massive deforestation to create agricultural land, monoculture plantations for wood as raw material, use of pesticides and fertilizers, relocation of industries from cities to small towns, construction of highways, mining activities and use of inefficient *chullas* for cooking all of these actions contribute to rural air pollution.

Deforestation

- Green plants play an important role in controlling pollution. They absorb air pollutants, release life-giving oxygen and cool the air when water evaporates from their leaves.
- Large scale cutting of trees in rural areas has hampered this natural mechanism for checking pollution. Local people are consequently much more vulnerable to health problems.



Use of pesticides and insecticides

- One of the supposed benefits of the Green Revolution was the invention of chemicals to kill plant and crops pests. However, the targeted pests slowly adapted and became resistant to these chemicals, and non-targeted creatures— insects, birds and even humans suffered due to these harmful substances.
- Some hazardous pesticides like DDT (dichloro-diphenyl-trichloroethane) and benzene hexachloride were soon blacklisted. Though banned in other parts of the world, these pesticides continue to be used in India and are a major cause of respiratory diseases, cancer and other genetic disorders in humans.

Case 6: Dreaded DDT

DDT, as an insecticide was discovered in 1939. After World War II, it became especially popular due to its effectiveness against mosquitoes that spread malaria. The World Health Organization estimated that 25 million lives were saved because of its use.

Problems soon surfaced when many insects began to develop resistance to the insecticide. DDT was also discovered to be highly **toxic** to fish. It builds up in fish's fatty tissues and does not break down easily. Animals that ingest DDT carry it for long time. It takes an animal eight years to break down even half of the DDT it consumes. Many fish-eating birds were threatened due to DDT consumption, as a result it was banned in most of the countries. But it is still used in India. In humans, DDT enters the body through food that has been sprayed with the pesticide; shockingly it can pass from mother to child through mother's milk.

Studies reveal that Indians have one of the highest concentrations of DDT in their body. Due to widespread use of DDT, many mosquitoes have become resistant to the insecticide.



Air

Cooking

- Indoor air pollution in rural areas is dominated by the heavy smoke produced due to the burning of cooking fuel.
- Bio-fuels used for cooking, such as firewood, agricultural residue and coal, are believed to be the most potent pollutants, releasing carbon monoxide and formaldehyde when burnt.
- In rural Maharashtra, indoor pollution is the main killer in the kitchen, mainly affecting women and children, causing respiratory illnesses like bronchitis and pneumonia.
- There is growing evidence that carbon monoxide contributes to heart diseases by enhancing the carcinogenic effects of other pollutants. It inhibits the ability of lungs to clean them.



Global Concerns

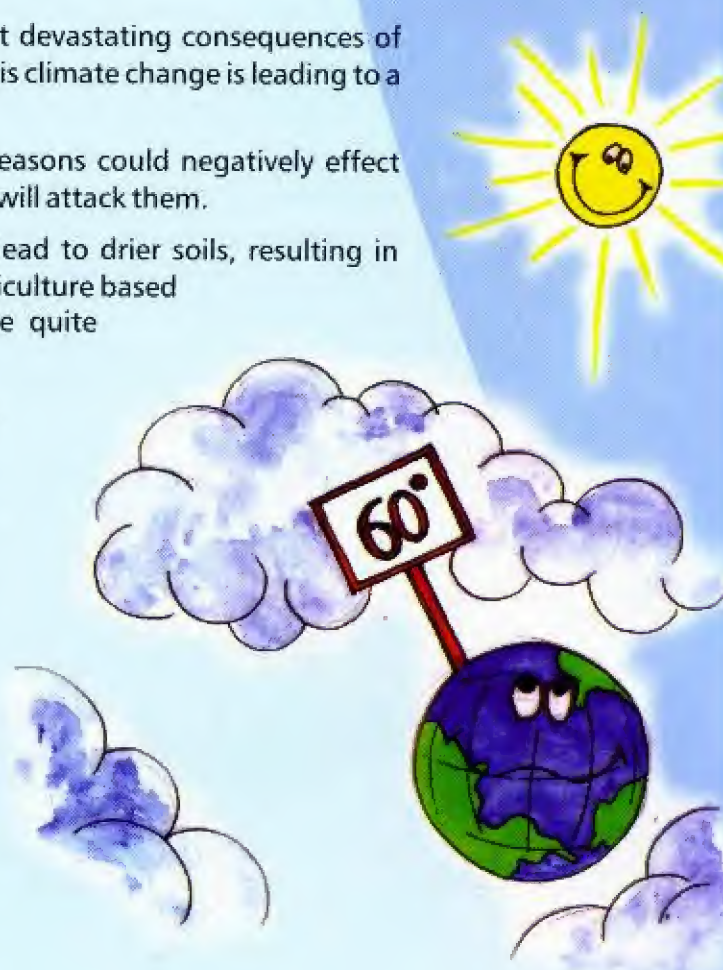
Green House Effect

- Green house gases (GHG's) like carbon dioxide, methane and nitrous oxide are usually present in the atmosphere at levels less than 1%. However, manmade activities have increased the levels of GHGs by introducing chlorofluorocarbons.
- Indiscriminate burning of fossil fuels has led to a phenomenal increase in the level of carbon dioxide in the atmosphere.
- The destruction of forests has led to the reduction in capacity of absorbing pollutants thus raising the level of carbon dioxide in the air.
- Excessive carbon dioxide in the atmosphere forms a kind of trap, preventing the sun's heat from escaping the earth, thereby making it hotter and hotter. This undesirable extension of the natural green house phenomenon is popularly known as the "green house effect."
- By controlling the emission of CFCs, the green house effect could be minimized.
- Man has adopted the principle of the natural green house effect to grow crops, fruits and flowers in places where the climate may not be suitable. A man-made 'green house' allows sunlight to enter through a building through glass panes, but does not allow the heat rays to escape, thereby maintaining warmth for the plants to grow inside.



Global Warming

- The 'greenhouse effect' has caused temperatures to rise all over the globe, a phenomenon that has been termed 'global warming'.
 - Statistics reveal that since 1998, our summers are getting increasingly hotter. Changes are most obvious in drought prone areas where droughts are becoming hotter and longer and the rainy season more erratic and unpredictable.
 - Loss of life and property are perhaps the most devastating consequences of climate change. However, the abnormality of this climate change is leading to a host of other concerns as well.
 - Changes in the length and temperatures of seasons could negatively effect crop growth, and change the type of pests that will attack them.
 - Increased evaporation in certain areas could lead to drier soils, resulting in prolonged, severe drought situations. In an agriculture based country like India, such changes could prove quite dangerous.
 - Water-shortages produced by climate change, combined with an ever-increasing population, are likely to cause conflict amongst people seeking access to potable water.
 - As a result of global warming, ice caps are melting at a faster rate, causing ocean levels to rise. Rising sea levels could easily lead to inundation of coastal areas and small islands. In the Himalayas, the glacier at Gaumukh, which feeds the River Ganga, has begun melting at an alarming rate.
- In the animal world, those creatures that cannot tolerate their warming habitat are likely to shift to even higher altitudes. However, unless they are able to adapt to new climates, they may perish instead



Thinning of the Ozone Layer

- The ozone layer of the atmosphere protects the earth against harmful ultraviolet rays of the sun.
- Excessive use of refrigerants, **solvents** and air conditioners emit chlorofluorocarbons (CFCs) in the atmosphere. These CFCs react with ozone molecules and release atomic chlorine, thereby creating a hole in the ozone layer.
- Ultraviolet radiation results in increased cases of skin cancer and cataracts in humans.
- Ultraviolet radiation also retards plant growth and can alter plant physiology and also harms small living organisms, such as **zooplankton**, **phytoplankton**, shrimp larvae and the young of fish.
- Usage of ozone friendly products will ease the effects of thinning of ozone. Also taking appropriate skin care would avoid skin-related diseases caused by UV radiations.

Acid Rain

- Remember the days when both children and adults ran to the roof tops to bathe in the first rain? They believed that the rain would free them from all diseases. Normal, ecologically "healthy" rain is slightly acidic (pH 5.6.) This acidic water could act as a cleansing agent for our skin. However there is no "healthy" rain on our planet these days.
- Industries, automobiles and power plants give out tonnes of nitrogen oxide and sulphur dioxide into the air every year. These gases dissolve in rain water, forming sulphuric and nitric acid that returns to Earth as acid rain.
- Acid rain has a pH lower than 5.6. In 1974, the rain water at Trombay and Chembur in Mumbai recorded a pH of 4.5.
- Acid rain not only destroys monuments and buildings but also affects the soil, pollutes water bodies and thereby poses a hazard to the creatures living in these places.



Case 7: Dying Monuments



The Taj Mahal, very well known as the symbol of love, is the most environmentally threatened monument in our country. Today, the magic in the marble is slowly fading, thanks to the 250 environmentally dangerous iron foundries located in the Agra district that give out huge amounts of smoke loaded with sulphur dioxide. With the onset of rains, the sulphur dioxide gets converted to sulphuric acid and comes down as acid rain. This gets deposited along with fine particles of soot, on the walls of the monument. As the marble walls have high calcium content, they are vulnerable to easy corrosion by acid rain. In ancient times, the monuments in our cities were protected by huge belts of trees and other vegetation around them. Now, loss of vegetation, coupled with high human activity has hastened the process of degradation. The Red Fort in Delhi, the

Victoria Memorial in Kolkata, the Sun Temple at Konark in Orissa and even the Rashtrapati Bhavan which is only half a century old are being affected by air pollution and acid rain.

Our festivals and air

Diwali

- The festival of lights was traditionally celebrated by lighting diyas to welcome Lord Rama after his exile.
 - This quiet celebration of ancient times has been now replaced by noisy and toxic air pollutants: crackers. These crackers cause chemical air pollution and noise pollution, both harmful to human and animal lives.
 - Moreover child labour is employed to manufacture these crackers exposing the young workers to severe health hazards.
- For a pleasant Diwali:
- refrain from bursting crackers and light diyas. They are beautiful, quiet and safe.



Holi

- In times gone by, the festival of colours was celebrated by playing with organic colours prepared from natural sources like palash flowers and turmeric.
- These colours have now been replaced by dyes meant for industrial uses which contain heavy metals, acids, alkalis, powdered glass and asbestos. The colours used in present times can cause skin allergies and cancer, and can lead to blindness.
- Moreover, for days after the festival, these particles remain in the environment, mixing with dust to become even more toxic. The tradition of 'burning holi' is a cause for concern too. Indiscriminate use of wood and in its absence use of anything flammable is a serious environmental issue.

For a harmless Holi:

- Play with safe natural colours (there are many ways of preparing them)
- Control use of wood for Holi bonfires and have a large community bonfire rather than many smaller ones



Ganesh Chaturti

- The Ganapati festival dates back about 250 years, when it was celebrated over the course of two days.
- By the eighteenth century, celebrations had stretched to six days. It was then largely a family festival. In 1894 the festival got a new 'look' when Bal Gangadhar Tilak aimed to make it a platform for the fight for independence, unifying the aspirations of the local population and other Indians. As a result, community Ganapati idols were set up.
- Today, with the core ideas of unity and social uplift relegated to the background, the festival has lost its meaning. It has become highly commercialized. As a result, more and more groups flaunt *pandals* with huge Ganapati idols, loudspeakers and other paraphernalia.
- In Mumbai alone there are more than 3,500 different groups celebrating the festival, not to mention the idols worshipped at homes.

This is a serious cause for concern because:

- Celebrations cause distressful noise pollution in city areas
- Idols are often made of plaster of paris (POP) and painted with lead colours. When immersed in a water body at the end of the festival, the idols release toxins that pollute the water, harming fish and other water life.

For a safe Ganesh Chaturthi:

- Use small idols made of clay painted with non-toxic colours, or eco-colours.
- Idols could be also made into two dimensional structures rather three dimensional ones. Or as is done in West Bengal, where Durga idols are hollow rather than solid. As minimum clay is used, the harm caused is also less.
- Some people have opted for metal idols instead of clay ones and worship the same ones year after year.
- Opt for quieter social gatherings without microphones or loudspeakers.



This is an eco friendly Ganapati made of clay and painted with non toxic paint



Air

Air-in-law

- In India, there has been a steady and alarming drop in air quality air in the past two decades. Although India has passed a number of environmental protection laws, they are not strictly followed.
- One of the early laws passed was the Air (Prevention and Control of Pollution) Act in 1981. Under this act, no one could start an industrial pollution causing activity without the permission of State Control Pollution Board.
- In 1986, the Environment Protection Act was passed as a result of the Bhopal gas tragedy. Under this act, the central authority could close down a polluting industry or cut water and power supplies to polluting units.
- As per the Central Action Plan (1992), eight industry categories (namely iron, steel, fertilizer, zinc, copper, aluminum smelters and oil refineries) were classified as highly polluting. Accordingly, new industries of this type are forbidden in ecologically sensitive areas.
- The Central Motor Vehicles Act of 1939 was amended in 1989 to regulate vehicular emissions.
- Unfortunately, these laws have been largely ineffective. Due to unfocussed and improper planning, fragmented laws, and lack of discipline in implementation, the aim of improving air quality is still nowhere close to fulfillment.



Case 7: CNG and Delhi

In 1996, K.R. Narayan released *Slow Murder: The deadly story of vehicular pollution in India*, a book written by The Centre for Science and Environment (CSE). Following the book's release, CSE organized a public meeting on the Right to Clean Air. The meeting was followed by media reports and an action plan to control air pollution in the city of Delhi. As a result of this initiative, the Delhi government was forced for the first time to create an action plan to curb air pollution. Presently the Delhi public transport runs on CNG i.e. Compressed Natural Gas that has subsequently brought down pollution levels.

Case 8: A People's Initiative: Chembur Smoke Affected Residents Forum

Residents of the Chembur area of Mumbai city were victims of air pollution not only because of vehicular traffic (like the rest of the city dwellers), but also because of the toxic discards of industrial effluents.

According to an estimate made by the Indira Gandhi Institute of Development Research (IGIDR), poor air quality cost people living in Chembur as much as Rs 35 lakh each year in health care. Organizations like the Smoke Affected Residents Forum (SARF) litigated successfully against the polluting industries. In 1997, the High Court ruled in SARF's favor over the deadly practice of burning waste in Deonar, a garbage dump. This has had a positive effect. Chembur is no more known as a gas chamber. Today, it is much greener and has a better environment.

People initiative

The future may look bleak, but all is not lost. Intervention and prevention now could ensure that we, as well as future generations, will breathe clean air and lead healthy lives. Here are some more tips towards cleaner air:

- Choose aerosol sprays, refrigerators, air conditioners and paints that are ozone-friendly.
- Seal containers of household cleaners, workshop chemicals and solvents, and garden chemicals to prevent evaporation.
- Cut down electricity usage by switching off appliances when not in use. This small action will reduce the demand for power and also affect the emission from thermal power stations.
- When cooking, avoid use of bio-fuels like dung, firewood, and switch to LPG, biogas or solar energy.
- Switch from an open chullah to a smokeless chullah with a covered chimney. Smokeless chullahs consume less fuel than the traditional open chullah and reduce smoke emission.
- By making use of existing laws and effective action plans pollution can be controlled both individually and as a community. In both cases, education and awareness play a vital role.

Citizens need to be aware of pollution, and of their rights and responsibilities towards themselves and towards society at large. Awareness is the only way that we can ensure a healthy future.

A few pointers for industries:

- Industries must use **bag filters**, wet collectors and gas absorbers to check air pollution
- Factories should be encouraged to grow more pollution-tolerant tree species.
- Vehicles should use unleaded petrol and must be well-maintained, undergoing regular Pollution under Control (PUC) checks.
- Public transport should be used whenever possible and car-pools encouraged. Walk or take a bicycle for shorter distances.



Glossary:

Adrenaline:	Hormonal secretion of the endocrine gland situated near the kidney.
Aquifers:	Underground bed or layer of earth, gravel, or porous stone that yields water.
Bag filter:	Fabric used as a filter for dust-laden gas.
Bronchitis:	Acute or chronic inflammation of the mucous membrane of the bronchial tubes.
Byssinosis:	Chest related disease marked by bronchitis.
Dumping ground:	Open space which is used for dumping garbage for a population.
Eco-mark:	Symbol that denotes that the product is environment friendly.
Fly ash:	Suspended particles, dust, soot and products of combustion.
Gas chamber:	Instrument consisting of a sealed chamber into which gas is introduced.
Genetic:	Hereditary, or pertaining to a gene, that is a functional unit of heredity located at a fixed place on a chromosome.
Multinational:	Having operations in several countries.
Neurosis:	Disorders of the mind or emotions leading to abnormal behaviour.
Phytoplankton:	Microscopic floating plants.
Radiation:	Emission or propagation of waves or particles of sound, light and heat.
Textile:	Any type of material made from fibers or other extended linear materials such as thread or yarn.
Ultraviolet:	Range of radiation wavelengths beyond the violet in the visible spectrum.
Zooplankton:	Floating, often microscopic aquatic animals

Activity 1: How clean is the air around your school?



Objective: To assess the pollution of suspended particulate matter (like dust and soot) in the air around school.

Background: Explain the concept of air pollution to the children and nearest sources around the school of the same.

Subjects Covered: Science, Mathematics and Geography.

Approach: Learning by observation and analysis.

Materials required: Datasheet, cello tapes and pen.

Method:

- 1 Ask each child to put five broad double-sided cello tapes for a day in five different locations like the window of a classroom, door of a classroom, parking area, playground and staff room. Ensure that cello tape locations cover all four sides of the school building.
- 2 Ask children to bring their cello tapes next day and make them note down the locations where the tapes were placed. Particulate matter will have adhered to the tapes.
- 3 Make them grade the tapes according to the table given below.
- 4 Pool all results as per the locations and derive the heavily polluted side of the school
- 6 List the probable reasons for more or less pollution in the sampling areas.
- 7 Brainstorm on solutions to reduce the air pollution around school.
- 8 Prepare a report and share it with rest of the school.
9. Encourage students to undertake similar experiments around their homes.

Location	Number of cello tapes			Total
	Heavily polluted	Averagely polluted	Mildly polluted	
1. Window				
2. Door				
3. Parking Area				
4. Staff Room				
5. Playground				
Total				

Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj



Air ACTIVITIES



Activity 2: Is air pollution a health concern ?

Objective: To find out effects of pollution on human health.

Background: Provide the facts about illnesses caused by air pollution.

Subjects covered: Science, Language, Geography and Mathematics.

Approach: Survey using questionnaire and analysis of data.

Method:

- 1 Talk to the local people and find out the kind of health problems they suffer from
- 2 Ask them why they think the health problem has arisen.
- 3 Each child should question at least ten different individuals.
- 4 Take the help of a doctor.
- 5 Report the data using the data sheet, given at the end
- 6 Make a list of health problems that can be directly or indirectly attributed to air pollution.
- 7 List the possible sources of air pollutants in the areas surveyed.
- 8 Suggest ways to curb the effects of air pollution and better health.
- 9 Write to the local health officer and share your results so as to bring better awareness of air pollution related ailments.

No	Age	Sex	Health problems mentioned by		Probable causes mentioned by		Preventive/curative measures suggested by	
			individual	doctor	doctor	individual	doctor	you

Activity 3: How sustainable is the development in your locality?

Objective: To assess sustainability of local occupations.

Background: Provide the facts about sustainable development.

Subjects covered: Social Sciences and Mathematics.

Approach: Survey by interviews.

Method:

1. Survey your area and make a list of large and small scale industries located nearby.
2. Talk to the elders and find out how many industries existed 10, 20, 30 and 40 years ago.
3. What was the kind of work they/their older generations did before working in industries? Make a list of these occupations.
4. If these occupations include forms of arts and crafts, involve locals; invite them to come to your school to teach the dying form of the art and craft of their village.
5. Explain to them how sustainable rural development is better than rapid unchecked development.

Air ACTIVITIES



Activity 4: How environment friendly is your transport?

Objective: To make students aware about various vehicular sources of air pollution and a way to reduce them.

Background : Explain the concept of public and private transport to children.

Subjects covered : Science, Geography, Language and Mathematics.

Approach : Learning by Survey and Communication.

Materials required : Paper and pen.

Method:

1. Ask the children to prepare a list of all the private vehicles that are used in day to day life, like scooter, car, motorbike, etc and to find the total number of each in at least five houses, school, and at various places. Ask to calculate the number of people, average distance they travel and total amount of fuel used by all of them. Give 4 points of pollution for each liter.
2. Now find out the amount of fuel used to travel the same distance by public transport. Give four points of pollution for each liter of fuel that is used.
3. Compare the points of pollution caused by public and private transport. The pollution points of private vehicles would be higher.
4. Explain to the children why using public transport could be a very important tool to reduce air pollution.
5. As an extension, ask children to also collect information on unleaded petrol, leaded petrol and CNG run vehicles.
6. Explain the advantages of unleaded petrol and CNG as an environment-friendly fuel.

Activity 5: Be an air pollution detective

Objective: To make the children know about various indoor and outdoor activities or things that lead to air pollution and the different types of air pollution that they come across in their day to day lives.

Background: Explain different types of air pollution; make a list of possible existing types of air pollution.

Subjects covered: Science and Social Studies.

Approach: Learning by observation and outdoor work.

Materials required: List of air pollution types and pen/pencil that they have compiled and measures that could be taken to reduce such pollution.

Method:

1. Give each child a list of various possible air pollution types, like vehicular pollution, industrial pollution, pollution by burning of tyres, paper, and wood, pollution by chullahs, pollution by burning crackers, pollution by dust particles.
2. Ask them to keep the list as reference and prepare a list of outdoor and indoor types of air pollution that they come across at various places in a seven day span.
3. Instruct students to notice pollution at all the places they visit which may be their school, home, playground, friends place, hotel and roads.
4. Ask them to assign the pollution as outdoor or indoor, dangerous or less dangerous as they feel and measures that they could think of to reduce such pollution.
5. Discuss with the students the ill effects of the different types of pollution



Water



*My soul is full of longing, for the secret of the Sea,
And the heart of the great ocean, sends a thrilling pulse
through me.*

-Henry Wadsworth Longfellow

After air, another life sustaining gift by mother Earth to us is Water. This chapter deals with issues pertaining to water which will encourage you to undertake action needed for conservation of water. Let us start with the basics of water, which will help us have better understanding of this life-saving liquid.

Water- A vital resource

- Water is a key resource, vital to life; it underpins society, economies and the environment. But, it is also a scarce resource specially the freshwater.
- Water is not only the most important commodity today to all people (regardless of race, colour or gender, and regardless of whether you live in Manhattan, Melghat or Mumbai), but it is more or less the lifeblood of mankind.
- It is a limited and finite resource, unevenly distributed in time and space, and already scarce in many areas. There are millions and millions of people in many countries around the world who walk several kilometres each day to bring home essential amount of water for their survival.
- On the other hand, there are millions and millions of acres covered with water. Water everywhere but not a drop to drink, as roughly 97% of the water on earth is seawater. World oceans cover about three-fourths of Earth's surface.
- According to the UN estimates, the total amount of water on earth is about 1400 million cubic kilometers (m.cu.km.) which is enough to cover the earth with a layer of 3000 metres depth. However, fresh water constitutes a very small proportion of this enormous quantity.

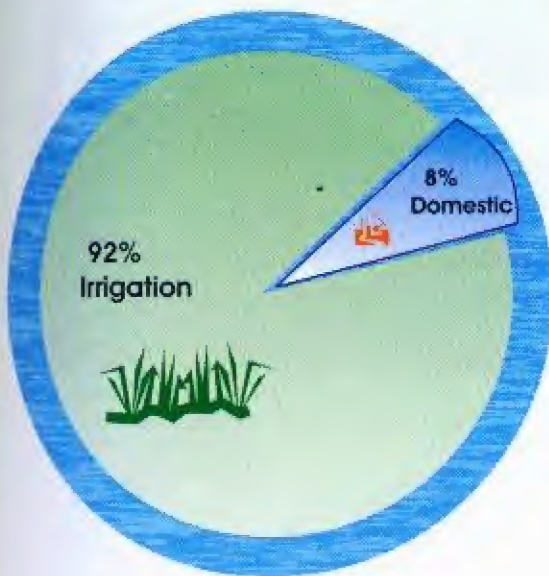
Sources	Water availability (m.cu.km.)
Oceans	97.20
Icecaps	2.00
Ground water	0.62
Fresh water lakes	0.009
Inland seas & salt lakes	0.008
Atmosphere	0.001
Rivers	0.0001
Total	99.8381



- What is effectively available for consumption and other uses is a small proportion of the quantity available in rivers, lakes and ground water.
- The crisis over water resources development and management thus arises because most of the world's water is not available for use and secondly because water is characterised by its highly uneven spatial distribution. Accordingly, the importance of water has been recognized and greater emphasis is being laid on prudent use of water and on better management of this precious resource.
- India is one of the wettest countries in the world with 1,170 mm rainfall. Cherrapunji in Meghalaya receives the highest rainfall of 11400 mm while Jaisalmer in Rajasthan receives the lowest rainfall of 210 mm.



Demand for water in 1974



- Considering that most of the temperate countries are bereft of monsoon, our country is blessed, yet we are not making the best use of our blessings. Even though by 2025 A.D. India will use only a fourth of its total annual rainfall, it is facing the threat of shortages right now. The reason for this is simply that India cannot hold on to all the water it receives. Despite an increasingly desperate situation, India continues to use its water resources as if the supply is assured.

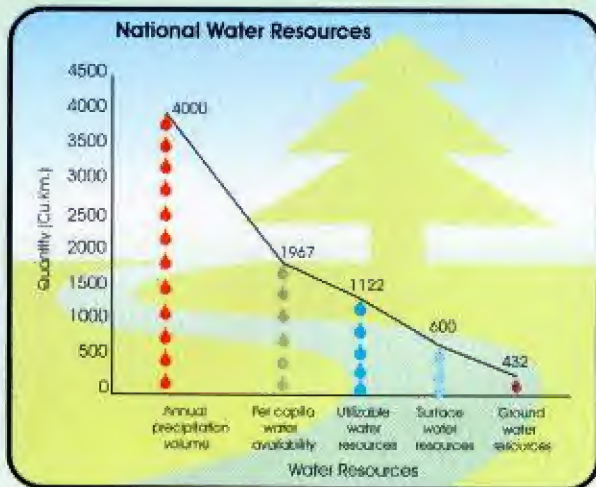
- In rural areas, water scarcity or the lack of access to water forces people to consume less. Even if all domestic and industrial needs are adequately met by 2025, 73% of water would be still used for irrigation alone.

Did you know?

India receives nearly 4000 cubic kilometers of fresh water annually through the seasonal monsoon rains and rivers that flow down from the snow capped Himalayas and other mountain ranges. Yet, today about 20 crore people in India do not have access to safe drinking water. India stands second in population but 108th in per capita water available in the world.



Water

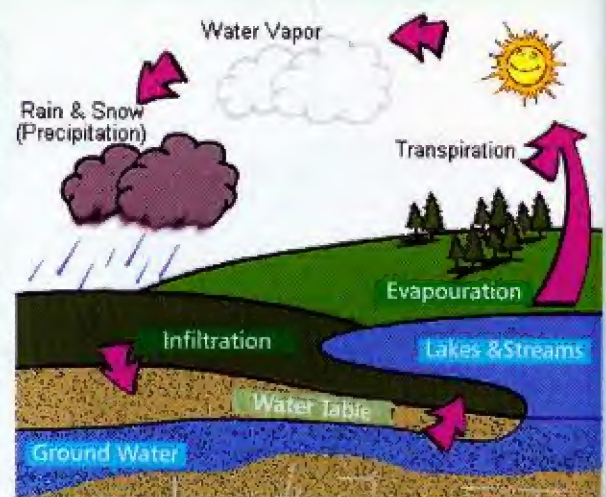


Water World

- Water is unique, as it is the only natural substance that can be found simultaneously in all three states as a liquid, a solid (ice), and a gas (water vapour) in temperatures normally found on Earth. This water is constantly moving, interacting and changing.
- The primary source of water for life is **precipitation**, in the form of rain, snow and hail. Rain is the most important of these forms. After rainfall, rainwater sinks into the soil, generating underground water sources, and flows on the land's surface into rivers and lakes.

Water Cycle

- We all know how villagers travel long distances to get water. Such travel is necessary because water is locked at one spot, which is often far from their home. Just imagine how life would be if all of the world's water remained locked in one corner of the earth. Fortunately in nature, this does not happen.
- Water moves continuously between the **atmosphere**, the land and the oceans in a cyclical manner. This natural process is called the Water Cycle. The water cycle helps us get water closer to our homes in rivers, lakes, ponds and wells. At a given time in any water source, some water is added, some is lost and some remains in its place.



Freshwater Resources

- The most abundantly required form of water i.e. fresh water is a rather limited resource on our planet. And it is becoming even more limited due to excessive use and contamination. Our freshwater resources include:
- Flowing water e.g. rivers and streams
- Stagnant water e.g. lakes, tanks and ponds
- Ground water systems e.g. wells
- The freshwater flowing system includes streams and rivers. Rivers and streams play a vital role in the global water cycle by draining water from land into the seas and oceans. They may be perennial, that is, having water all through the year; or non-perennial, having a seasonal supply of water and tending to dry up in summer.
- Lakes are formed when water collects in a deep natural or man-made depression. It gets its water from a stream or river or an underground source.

- Ponds can be both constructed (usually near temples), or accidentally formed, such as when rainwater collects in an area dug up for mining or construction.
- Besides lakes and ponds that serve as natural reservoirs for water storage, we also have created artificial **reservoirs** created by damming streams or rivers in order to obtain a continuous supply of water.
- **Ground water** is generally obtained from wells. These could be open shallow or deep wells, tube wells (borehole wells) and **artesian wells**. Ground water **aquifers** are found at a depth of less than 750 meters. The **water table** varies depending upon the weather conditions, topography and percolation of water from surface to sub-surface.

Did you know?

India's groundwater resources are almost 10 times its annual rainfall. But with over 170,000 tubewells added every year during the 1970's, the water table is declining in many areas, leaving the dug wells of the poor high and dry.



Agriculture in India

- Among Asian countries, India has the largest arable land, which is close to 39 per cent of Asia's arable land. Only the United States of America has more arable land than India.
- In India, **topography**, soils, rainfall, and the availability of water for irrigation have been major determinants of the crop and livestock patterns.
- The monsoons play a critical role in determining whether the harvest will be bountiful, average, or poor in any given year.

Did you know?

Dam waters now cover nearly one percent of India's land area, but produce little fish and provide little employment for the impoverished fisherfolk: the highest annual yield of a reservoir is only 190 kg a hectare annually, but some fish ponds record 8,000 kg. a hectare.



Water

Water Pollution

- It is said that the world's next battle will be fought over access to freshwater. We have been discussing how scarce this precious resource is, yet we are unable to take care of the water that we have. Water pollution is a major problem affecting our freshwater bodies.
- Water pollution has many sources. The most harmful sources are domestic **sewage** and industrial waste water. These waters should be cleaned before being disposed of, but facilities to treat them are not adequate. Because of this lack of treatment, pollutants enter groundwater, rivers and other water bodies. Such water, which ultimately ends up back in our households, is often highly contaminated and carries disease-causing microbes.



Now we have to fight for water

Where do the pollutants come from?

- Domestic waste.
- Industrial effluents.
- Agricultural discharge.
- **Siltation.**
- Thermal Power Plants.
- Radioactive materials- Radioactive materials contaminate water through four major activities:
 - Surface runoff from uranium mining and effluents of units that process radioactive minerals such as uranium and thorium.
 - Nuclear weapons testing and leakage from underground nuclear detonation.
 - **Effluents** from nuclear power plants.
 - Use of radioactive isotopes in medical, industrial and other research applications.



Did you know?

Two of the high-altitude lakes in India are steadily dying because of pollution. The slow death of Kashmir's Dal lake is threatening the livelihood of 50,000 fisherfolk. Increasingly polluted rivers, lakes and large dams are seriously affecting riverine fisheries. The migratory hilsa fish, a much sought after delicacy, is being dammed to death.



Ground Water Pollution

- Ground water is less susceptible to pollution than surface water, but its pollution is more difficult to detect and to rectify. The pollution of air, surface water and land leads to pollution and contamination of ground water.

When the air is polluted, rainfall dissolves air pollutants, which then settle on the ground. The pollutants then seep into the soil and contaminate ground water resources.

Case 1: Har-Har Gange

The Ganga, which is thought to be the holiest river of India, can no longer be considered as the country's purest. In many places, its waters are so polluted as to have an adverse effect on life-forms. Traces of DDT and other pesticides have been found in the river. These pesticides have been found to accumulate in the dolphins of the Ganga.

The safe limit of **DDT** concentrations, proposed by the World Health Organisation (WHO) is 1mg/litre. DDT concentrations in the Ganga were often found exceeding 1mg/l. The **blubber** of river dolphins was found to have a DDT concentration in the range of 30 to 120 mg/gram.

The high level of DDT accumulated in the dolphins is due to its widespread use for controlling Malaria and Kala-azar in India. Also, DDT manufacturing units close to the holy river frequently dump their waste into it, contributing to the elevated concentrations of DDT in the river.

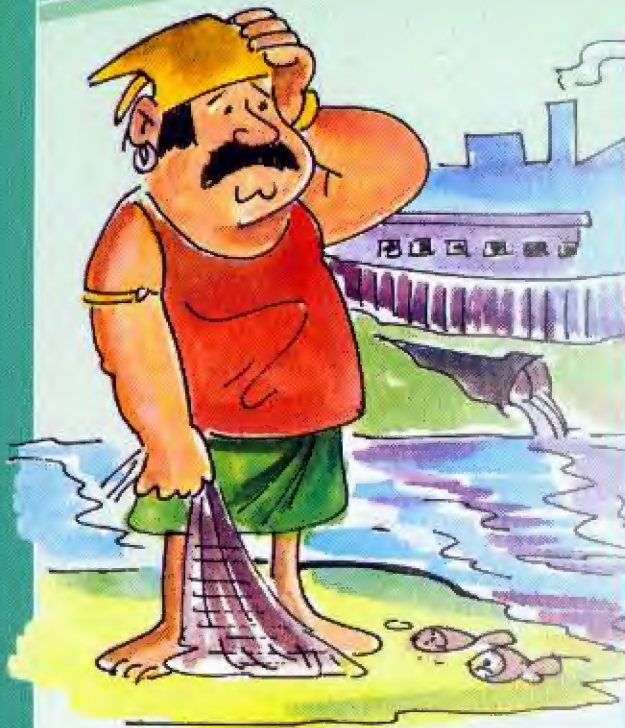
High concentrations of this pesticide are known to harm the diseases-fighting cells and reproductive capacities of aquatic mammals. The continuous pollution of the Ganga is adversely affecting the dolphin population and the creatures' numbers are waning. Construction of dams on the river, increased motor-boat traffic, and fishing and hunting of dolphins for meat and oil also threaten the Ganga dolphin.



This slimy water is bad for my complexion

- Leaching** of pollutants from pesticides and fertilizers and from industrial waste and the municipal solid waste seep into ground water, contaminating it. Recent studies indicate that the problem is growing, and quite seriously so in some parts of the country. Some of the culprits are: textile printing and dyeing units in Rajasthan, tanneries in Tamil Nadu and Uttar Pradesh and the coir processing industry in Kerala.
- Rampant deforestation due to construction of large dams, expansion of roads, mining, timber extraction, agricultural expansion, over-grazing affects the ability of the forest to harvest rainwater and store it in aquifers, lakes and reservoirs.

Water



Case 2: Fishy Story

Binaga is a small fishing village on the Karnataka coast near Karwar town. For more than a decade the fisherfolk have had to contend with one of the largest ecological menaces today: irresponsible industry. The culprit is the caustic soda factory of the Ballarpur Industries. The Karnataka State Board for Prevention and Control of Water pollution had allowed the factory to discharge effluents temporarily into the nullah Karwar.

Within three days of its operation, nearly half a ton of dead fish floated down the nullah to the sea. Nearly 170000 Rampani fisherfolk were affected along a coastal stretch of 10 km. The fisherfolk were agitated and, despite their protest and hunger strike, the industries continued to take toll on the fish population until the government took an active interest in curbing the pollution and providing better means of fishing to the fishing community.

Seawater pollution by oil spills

- Accidents in oil pipelines, oil refineries, and oil carrying or storing tankers result in oil spills. Oil leakage from boats and automobiles eventually gets into and pollutes water bodies.
- Leaking or spilling of oil into rivers, bays and oceans is caused due to accidents of oil pipelines, refineries and oil carrying or storing tankers. This usually happens when oil is transported from one place to other.
- Oil spreads rapidly across the water surface and forms a thin layer called oil slick.
- As the spreading continues, the layer becomes thinner and thinner, forming a thin rainbow like sheen. This sheen can easily get coated on aquatic animals and birds. Oil-coated birds lose their ability to repel water, become heavy and drown.
- Oil destroys the insulating ability of fur-bearing mammals and exposes them to harsh environments. Additionally, water birds and mammals swallow tiny droplets of oil while catching food which can poison them to death.

Where has all the water gone?

- Although rainfall, the main source of our water supply, is renewable through the water cycle, the amount of water circulating in this system is constant.
- The key issue is that demand for water is increasing, exacerbating the imbalance between supply and demand.
- Demand is driven by demography (population). During the 20th century, global population tripled while demand for water increased six-fold.
- Higher living standards, urbanisation and wasteful use of water pushed up average per-capita consumption. The



greatest consumer of water globally is agriculture, which uses 70% of all water consumed irrigation being the highest demand.

- With the present world population of 5.7 billion still growing at a rate of about 90 million per year, global water demand is expected to rise by a further 2-3 percent annually in the decades ahead. But freshwater resources are limited and unevenly distributed.
- India, the per capita availability in terms of annual average utilizable water resources was 3450 m³ in the year 1951, and is expected to reduce to 760 m³.
- In the year 2050 India will be placed in the category of a **water-stressed** country. The total water available in Maharashtra in the year 2000 was 634 billion cubic meters. However, due to increase in population, per capita availability will be greatly reduced.
- The distribution and availability of water is not uniform across the country or through out the year. Surface water sources often run dry in summer and ground water availability varies, from rich aquifers of the Indo-Gangetic-Brahmaputra plains to the comparatively low yielding hard rock regions of peninsular India.



Fertiliser Run-off



Aquatic plants begin to grow & consume lot of oxygen



Fish begin to die

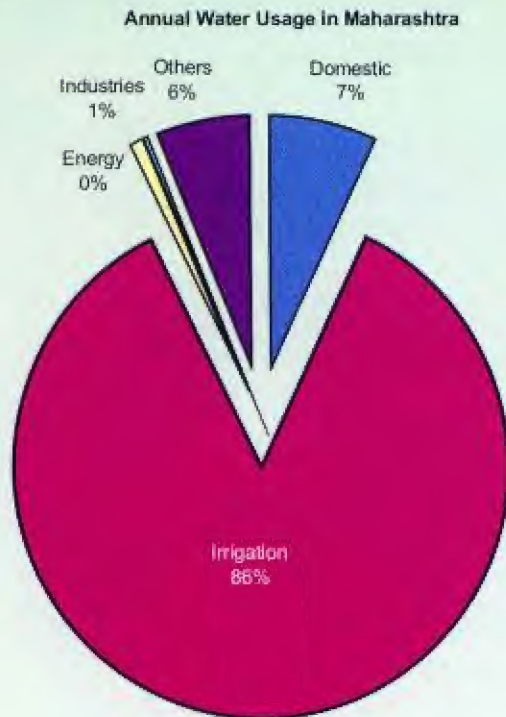


A dead lake

Dead Lakes

- The nutrient value of a water body increases with the addition of wastewater from houses, industries and fields. Nutrients are various minerals such as calcium, sodium, potassium, phosphate, carbonate, become abundant.
- These minerals are essential for growth of living beings but this sudden increase leads to large-scale growth in **algae** in the water body.
- As they respire, this huge quantity of algae depletes the dissolved oxygen in water. Thus, other creatures in water are suffocated to death.
- When these dead creatures decompose, they release toxic gases such as ammonia and methane, creating anaerobic conditions.
- Ultimately, there is a huge heap of dead mass in the water body. **Eutrophication** generally occurs in relatively stagnant water bodies as flowing water bodies are well aerated.

Water



Unsustainable use

- Ground water is an integral part of the environment and cannot be looked upon in isolation. Over-exploitation of ground water is a very real problem, with the water table falling steadily in many parts of the country.
- There has been a lack of adequate attention to water conservation, efficiency in water use and water re-use, ground water recharge and ecosystem sustainability.
- An uncontrolled use of bore well technology has led to the extraction of ground water at such a high rate, that recharge is often not sufficient. The causes of low water availability in many regions are also directly linked to reduced forest cover and soil degradation. Intensive agriculture and over-irrigation contribute to land degradation, particularly **salination**, **alkalization** and **water logging**.

Case 3: River Linking? Good or Bad

The much-hyped *River-linking Project* (RLP) proposes to link 14 Himalayan rivers in the north and 16 peninsular rivers in the south. The benefits of such a scheme are obvious - it would add 35-37 million hectares of irrigated land, generate 34,000 million kilowatts of electricity and increase navigational efficiency, apart from controlling floods and eliminating chances of drought. The surplus water to underfed areas will solve the perennial problem of floods and droughts and bring a boom in employment, but there is another side to the coin which spoils the rosy picture.

A number of leading environmentalists are of the opinion that the project could be an ecological disaster. There would be a decrease in downstream flows, resulting in reduction of fresh water inflows into the seas, seriously jeopardizing aquatic life. As per the study carried out by environmentalist Vandana Shiva, all rivers change their course every 70 to 100 years as a natural phenomenon that cannot be altered. One may link them today but once the rivers start changing their course in a few decades, the entire project would be in vain.

Also, there would be loss of biodiversity, reduction in downstream flows, damage to fisheries and wild life, displacement of people, conflicts over water sharing and pressure created on land by cubic tonnes of water that might cause seismic tremors. Besides, water-logging due to dam construction and river linking would provide a breeding ground for water-borne diseases.

So, is the move to link the rivers feasible and desirable?



Did you know?

In Western Maharashtra (e.g. Sangli dist.) sugar cane is grown on a large scale. In order to irrigate the sugar cane crops, farmers leave water pumps on throughout the night. As a result the sugar cane fields become flooded. Due to over- irrigation the salts in the soil are brought up to the topsoil. This process increases the salinity of the soil. Increased soil salinity has made much of the region's land unproductive, resulting in failing crops.



Tackling the issues

- Any development of water resources must take into account social and economic needs, and future growth.
- For the diverse economies of the developed world, it is essential that not too much water is removed, as this affects both the land and the quality of water.
- Water quality is as important as quantity and over-abstraction affects both.
- Uncertainties such as changes in social and economic demand, and new national and global policies, make it difficult to predict future demand and supply.
- All are subject to climate change and new technologies. Rising needs for the scarce water resources require demand management. Demand management aims to reduce the use of water by employing water-efficient technologies and economic measures.

Know the rules!!

As per our Constitution, environmental protection is a fundamental duty of every citizen of this country. The constitution says "It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures." There are number of legislations that have been enacted for controlling/preventing water pollution, one of which is the Water (Prevention and Control of Pollution) Act, 1974. The objectives of the Water (Prevention and Control of Pollution) Act are to provide for the Prevention and Control of Water Pollution and the maintenance or restoration of the wholesomeness of water for the establishment, with a view to carrying out the purposes aforesaid, of Boards for the prevention and control of water pollution, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith.

Parliament later adopted the Water (Prevention and Control of Pollution) Cess Act, 1977. The Act empowers the Central Government to impose a quarterly tax on water consumed by industries. According to the Ministry of Environment and Forests, Govt. of India, 6624 cases have been filed by the Central Pollution Control Board (CPCB), State Pollution Control Boards (SPCBs) and the Pollution Control Committees (PCCs) under the Water and Air Acts. The problems in filing the cases is the lack of awareness among the public, the fear of the delays in the judicial system and the lack of interest shown by the legal community in taking up environmental cases which earn low fees.



Water

Helpful Solutions

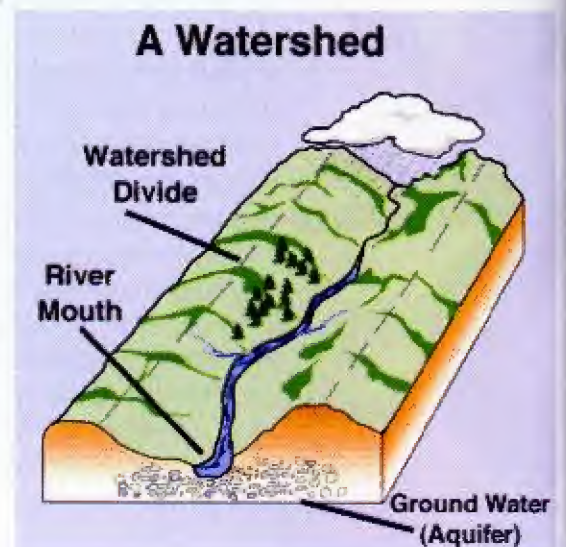
Rainwater Harvesting

- Rainwater is collected from the roofs of buildings and stored in rainwater tanks. Water can also be collected in reservoirs by channeling rainwater runoffs. By doing this, water can be stored and used for small scale irrigation (e.g. of kitchen gardens), washing clothes, and bathing. It can also be made **potable** after effective treatment.
- It's quite easy to harvest rainwater. Harvesting of rainwater simply involves:
 - Collection of water from surfaces on which rain falls.
 - Storing this water for later use.
- Rainwater harvesting can be an effective solution in areas where;
 - Piped water supply is not available
 - **Gray water** is needed because treated potable water is too expensive.
 - Dug well is not applicable due to lack of a suitable aquifer.
 - There is no water source nearby.
- In such areas rainwater harvesting may be the only way to access water for domestic purposes.
- By harvesting rainwater we can
 - Reduce our reliance on piped water supplies (consequently also saving on our water bills).
 - Reduce the flow of storm water, minimizing overloading of storm water systems, thus preventing neighborhood flooding (important especially during the monsoon).
 - On a larger plane, water harvesting lays less stress on municipal water storage and distribution and can potentially reduce the need for building more and larger dams.



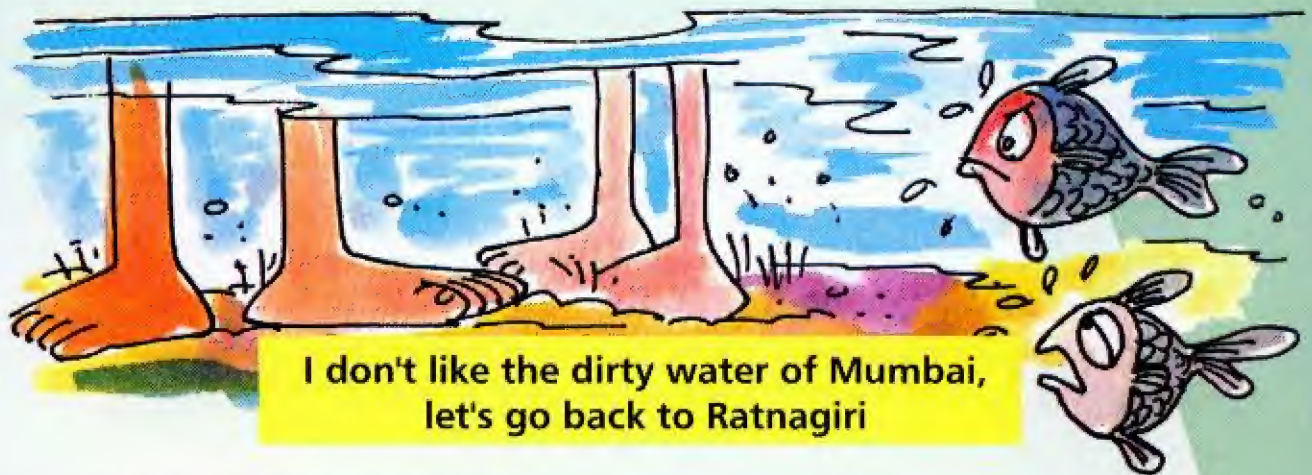
Watershed Management

- 'Watershed management' is a generic term for a cluster of agricultural and ecological activities in a river **catchment area** designed to raise the ground water level and increase the natural water supply in order to get better crops.
- Watershed work involves afforestation, plantation of grass and fodder trees, and construction of small '**contour**' dams on slopes. The contour dams are filled with earth and stones, and are planted with trees and bushes. They prevent the rainwater from flowing down and help it to seep into the soil.



Prevention and control of water pollution

- Only a part of the sewage is treated in most of the cities of Maharashtra. The rest goes directly into rivers, lakes or the sea.
- Mumbai was identified as one of the 5 critically polluted areas in India by the Ministry of Environment and Forests on February 14, 1992. According to this report only 10% of sewage in the city is treated, partly with secondary treatment. The balance goes untreated into the sea.
- An efficient sewage disposal system is important to the health of any community.
- Use of **biopesticides** would minimize the pollution caused by chemical fertilizers.
- Composting organic refuse would reduce the bulk entering into water bodies.



Environment-friendly agricultural practices

- The agriculture sector uses the maximum amount of available water. Therefore it is of utmost importance that it is used economically.
- Over-irrigation of crops should be avoided.
- **Drip irrigation** systems that regulate the watering process should be used.
- Rainwater flow on down hill farmlands should be controlled by contour farming, strip cropping and terracing.
- **Contour farming:** A contour is an imaginary line joining points at equal elevation. In this method crops are planted across the slope, slowing the speed of water as it moves down the hillsides and giving it a chance to soak in over a wide area.
- **Strip cropping:** Strips or bands of crops are planted along the contours. Strips of close and quick-growing plants such as fodder grasses are planted next to row crops such as maize, preventing soil erosion.
- **Terracing:** The sloping surface is converted into a series of wide, flat steps, one above the other along the slope. Stone walls support the edges of the slopes. Crops are planted on the flat surface of each step. This slows down the flow of run-off water and helps it to percolate into the soil and thereby recharging aquifers.



Water

Water conservation methods in daily life

Among the many environmental problems that our country faces, water pollution and water shortage are problems that need immediate attention. However, we as citizens continue our careless ways of dealing with water. It is high time we stop blaming the policy makers and help to save water in our own small way.

- When you turn on the tap maintain a slow flow.
- Install low-flow aerators to your taps.
- Fix leaking taps without delay.
- Turn the tap off while you brush your teeth or soap your face.
- Use a bucket while bathing rather than a shower or a bath tub.
- Ensure that the tap is closed while clothes/vessels are being scrubbed.
- Water from rinsing clothes need not be thrown, but can be utilized for mopping the floor.
- Utilise water from washing food items/ rinsing vessels for watering your plants.
- For drinking, take only as much water as you might use.
- Use rain water for soaking clothes and watering plants in the house.
- Wash vegetables and fruits in a pan of water, rather than under running water.
- Operate a washing machine only when fully loaded. Follow instructions for proper water level /load size selection. Rinsing-water in twin tub washing machines need not be drained off, but can be used for washing toilets and bathrooms.
- Water the garden early in the morning or late in the evening. This reduces water loss due to evaporation. Avoid over-watering plants. Water only until the soil becomes moist and not soggy. Water the plants with a mug, rather than with a hose.
- Collect and store as much rainwater as possible during the rainy season.



GLOSSARY

- **Alkalization:** Creating an alkaline property i.e. having an pH greater than 7.
- **Aquifers:** Rocks and sediments that can hold and transfer water.
- **Artesian wells:** Type of well drilled through hard surfaces at lower altitudes to receive water from higher altitudes.
- **Biopesticides:** Living organisms acting as pest controllers.
- **Blubber:** Layer of fat under the skin of some mammals that.
- **Catchment area:** Land area drained by a river and its tributaries.
- **Contour dam:** Hillside dams.
- **Drip irrigation:** method that releases water slowly directly to the soil at the roots of plants through pipes.
- **Effluents:** Flowing out.
- **Eutrophication:** Enrichment of an ecosystem with chemical nutrients, eg. Nitrogen, phosphorous.
- **Evaporation:** Process by which water turns into water vapour.
- **Gray Water :** Water that can be used for purposes other than drinking.
- **Ground water :** Fresh water that seeps through the soil in the monsoon, gets filtered and collected below the soil, in rocky beds. These water-locked rocky areas are called aquifers and the water found in them called ground water.
- **Hail:** Large irregular lumps of ice.
- **Leaching:** Process by which soluble matter is dissolved in ground water and carried downward and radially through the soil.
- **Potable Water:** Water that is safe for human consumption.
- **Precipitation:** Water vapour in the atmosphere turning into water.
- **Reservoirs:** Natural or artificial ponds or lakes used for storage and regulation of water.
- **Salination:** Accumulation of soluble salts by evaporation of water in poorly drained arid area.
- **Sewage:** Human generated waste water.
- **Siltation:** Process of deposition of sedimentary material called silt consisting of very small particles.
- **Topography:** Description of shape or form of landscape.
- **Transpiration:** Evaporation of moisture from leaves.
- **Water logging:** Rising of the water level and soaking of soils where land is poorly drained.
- **Water stress:** Condition when water consumption exceeds 10% of the renewable supplies.
- **Water Table:** Upper surface of ground water.

Water



ACTIVITIES

ACTIVITY 1: How much water we actually have?

Objective: To stress on the limited amount of water available on earth for human consumption.

Background: Information about water availability and water resources.

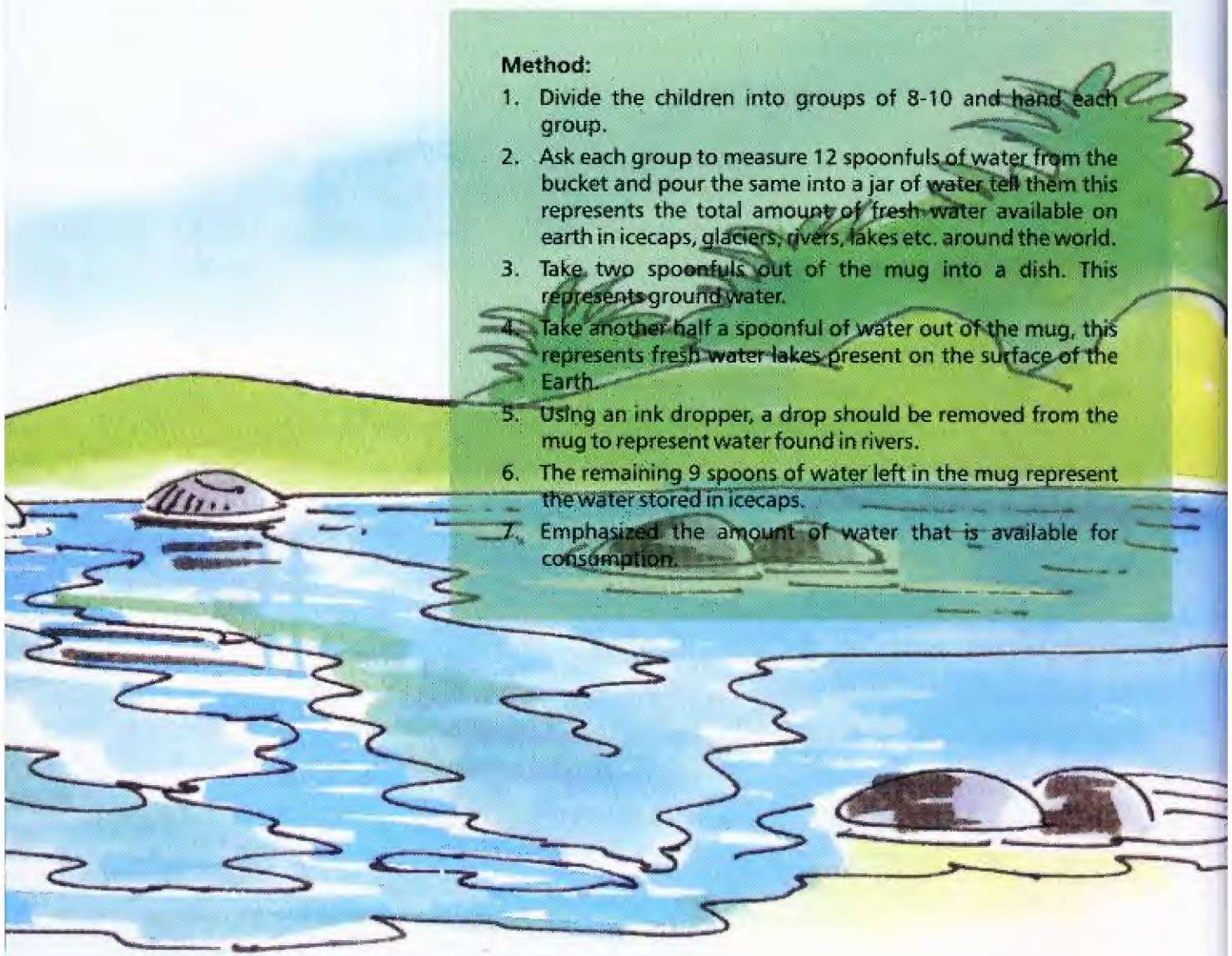
Subject covered: Mathematics and Social Sciences.

Approach: Demonstration.

Material required: 1 bucket of water, 1 dish, 1 mug, 1 ink dropper and 1 spoon for each group.

Method:

1. Divide the children into groups of 8-10 and hand each group.
2. Ask each group to measure 12 spoonfuls of water from the bucket and pour the same into a jar of water tell them this represents the total amount of fresh water available on earth in icecaps, glaciers, rivers, lakes etc. around the world.
3. Take two spoonfuls out of the mug into a dish. This represents ground water.
4. Take another half a spoonful of water out of the mug, this represents fresh water lakes present on the surface of the Earth.
5. Using an ink dropper, a drop should be removed from the mug to represent water found in rivers.
6. The remaining 9 spoons of water left in the mug represent the water stored in icecaps.
7. Emphasized the amount of water that is available for consumption.





ACTIVITIES



ACTIVITY 2 : How much water gets wasted in your school?

Objective: To explain the importance of water wastage.

Background: Information about water wastage.

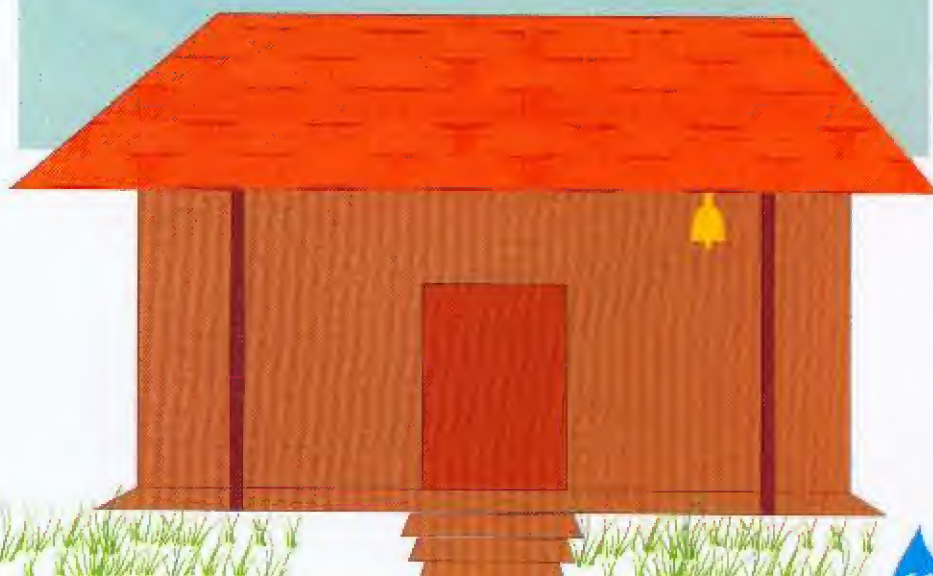
Subject covered: Mathematics.

Approach: Demonstration.

Materials required: bucket, a tap, measuring glass jar, watch, pen and paper.

Method:

1. Gather children to a water tap. Put a bucket of water under the tap and start the tap half a way tap so that small drops of water start dripping from it.
2. Ask one child to keep time for a minute and ask another child to hold a measuring glass jar under the dripping tap to collect the water.
3. After a minute the tap is closed and another couple of children are asked to read the measurement on the glass jar.
4. Ask other children to calculate the amount of water wasted in an hour, then in a day.
5. Hold a discussion on dripping taps around them and other ways in which water from taps is wasted. (eg. While brushing teeth, washing utensils) and compared to the dripping tap.
6. Brainstorm on causes and solution of tap leakages.
7. Get leaking pipes fixed by sharing the results with the principal and hold a presentation to the whole school on water conservation.
8. As an extension ask children to emulate same experiment in their houses and localities.
9. Encourage students to report any major water leakage problems in their locality to their nearest municipal's water department.





ACTIVITY 3. How clean is the water?

Objective: To bring about an understanding of water contamination and pure water.

Background: Sources of water pollution and its causes.

Subject covered: Science.

Approach: Experiment.

Materials required: Glass beaker, litmus paper, clean white muslin cloth and a magnifying glass.

Method:

1. Identify two sources of water, one contaminated and another pure source. Such as clear tap water, running stream, bore well or stagnant water body or industrial waste water, or polluted lake/stream could be examined.
2. Divide the class into groups of 8-10. Give each child a beaker, litmus paper, a clean white muslin cloth.
3. Ask the children to obtain the following results by observation and note down results by collecting each of the sample of clear water and impure water.
4. Children should make notes of the source of the water, the fauna and flora found in the water using the magnifying glass.
5. Encourage the children present their findings and describe their water sources.
6. Ask them to correlate the two and drawn their own conclusions.
7. As an extension, ask children to find out the purification process of impure water.
8. Arrange a visit to a water treatment plant for the same.

Parameters of Water Observation

- a) Colour - by observation
- b) Odour by smelling
- c) Turbidity- observe water against a white background to see whether it is clear or not
- d) Suspended solid particles: filter water through the muslin cloth and check any residue on the cloth.
- e) Acidic,alkaline or neutral: Using litmus paper, children should test the water:
red to blue: alkalinity; blue to red acidity, no change neutral.





ACTIVITIES

ACTIVITY 4. Do we really care for our water ?

Objective: To understand the source of water & its importance & to understand that access to water depends on several factors.

Background: Information about water conservation.

Subject covered: Science and Social Sciences.

Approach: Enquiry, interviews, research and observation.

Materials required: Pen and paper.

Method:

1. Ask children to observe and obtain the following information within a week's time:
 - Where does the water in your house tap come from?
 - Where is the source?
 - What does it flow in?
 - Do all your friends receive the same amount of water at home as you do?
 - Who controls the source of water?
 - How much water is used in a day in your home?
 - Has any body in your family ever suffered from a water borne disease? How?
 - Is there a season in which you face water scarcity in your home? Find out why.
2. Children should present their finding before the class, drawings should be encouraged.
3. Best project could be displayed on the notice board or presented to the entire school so that every student is aware of the sources of water.
4. As an extension, a visit to this water source could be arranged.



ACTIVITY 5. How to make a water parliament ?

Objective: To become aware of present water conflicts and develop a sense of enquiry and responsible decision making.

Background: Knowledge on current water issues especially in and around your city/town/state.

Subject covered: Social Sciences and Science.

Approach: Debate.

Materials required: Newspapers.

Method:

1. Children are to be divided into groups and should be given a topic on the current issues in and around their area or in their state or country.
2. They could be given week or two to research thorough newspapers, internet, asking elders, etc. topics could range between rivers interlinking, to water contamination to dams.
3. After a week hold a debate between groups
4. Bring the children's acceptable recommendations to light and sent it to the concerned authorities or to NGO's or printed /published in school newspaper.



Soil

"Essentially, all life depends upon the soil. There can be no life without soil and no soil without life; they have evolved together."

Charles E. Kellogg,

We have now reached to fourth important resource of our planet i.e. Soil. This is the basis of life without this non-living component all the terrestrial living components would not have existed. This chapter gives you a complete insight about soil and the way it has been used and misused. Soil is otherwise an ignored resource, through this chapter we glorify our soils.

Know your soil

- Everything that we use comes from land. From gold to rock-salt, from food to fuels, and the raw materials used in various industries.
- The land just below our feet, on which we all walk, is made of a basic component called 'soil'. The word 'soil' originates from the Latin word "solum" which means 'floor'.
- Soil is a thin layer of material on the Earth's surface in which plants have their roots. It is made up of many things, such as weathered rock and decayed plant and animal matter. Soil is formed over a long period of time.
- Though soil is an abundant resource, it is renewed very slowly. It may take thousands of years to create a thin layer of soil. The growing needs of people is ever increasing which is putting tremendous stress on our soil through agriculture.



Soil composition

- Interestingly the soil which we see as an individual entity is actually a byproduct of several natural processes that takes beneath underground.
- Soil differs from one location to another, but generally consists of organic and inorganic materials, water and air.
- The inorganic materials are the rocks that have been broken down into smaller pieces. The size of the pieces varies. It may appear as pebbles, gravel, or as small as particles of sand or clay.
- The organic material is decaying living matter. This could be plants or animals that have died and decay until they become part of the soil.
- The amount of water in the soil is closely linked with the climate and other characteristics of the region. The amount of water in the soil is one thing that can affect the amount of air. Very wet soil of the wetland probably has very little air. The composition of the soil affects the plants and therefore the animals that can live there.
- In Indian soil, the content of organic matter is generally low because of the high rate of decomposition under tropical and subtropical climate. Except in few localized areas in the hills and high-altitude regions, the organic matter in most of the cultivated soil rarely exceeds 1 per cent.



Case 1: Sand binders

Mangrove trees grow where no or few trees can grow. They are able to survive in soil which is poor in oxygen, and gets covered with salt water twice a day. At river mouths they deal with gushing waters that carry silt during the monsoon season, as well as violent storms that hit the coasts. How is this possible?

Mangroves have multi-purpose roots. This not only provide support in unstable soil, withstand currents and storms, but also breathe air! To avoid suffocation in water-logged marshy soil, mangrove trees develop aerial or air-breathing roots. These roots do not depend on soil air. They take in air from the atmosphere. The roots have special, tiny pores, to take in air and screen out water and salts.

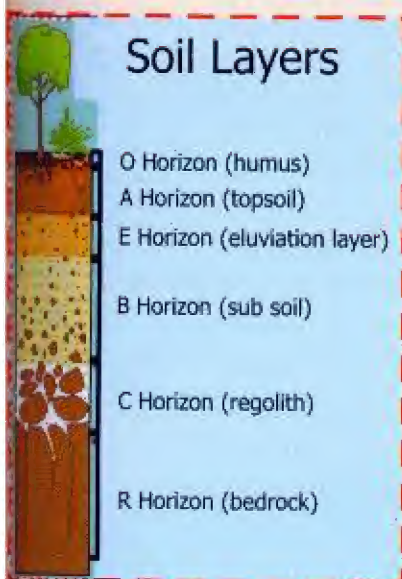
Mangroves are also called as sand binders as they don't allow the land to encroach into the water body. The powerful roots of mangroves hold on to the soil firmly and thus help in avoiding soil erosion. It was evident during the Tsunami that hit the Indian coast in January 2005 that those areas that had good cover of mangroves suffered fewer losses as compared to those that had none.

In Mumbai, M/s Godrej Boyce & Co. who own huge tracts of mangroves at Vikroli have been preserving them for several decades. This is a classic example of mangrove conservation.



Soil profile

- A visit to an abandoned **quarry** or a construction site reveals that the earth's crust or soil is made up of multiple layers. These layers are called soil horizons.
- Each layer has a different appearance, composition and use. However, **reclaimed** land does not show any soil profile. This is because the land has been artificially created by dumping soil in lakes, seas and **creeks**.



- The arrangement of soil horizons in naturally formed soil is known as a soil profile. There are four types of horizons described below:
- Organic layer or Horizon O: In forests or other areas that have not been ploughed or tilled, this layer is very prominent. This layer has millions of dead plant, animal and other organisms that are slowly decomposing away. As these decay, the soil becomes rich in nutrients known as humus. It provides nutrients to plants and soil organisms. The layer is about an inch thick and takes almost 100 to 600 years to form
- Upper soil or Horizon A: This is the layer where plants spread their roots; different types of insects, fungus, and tiny organisms make their home in this layer too. This soil here is dark in color because of chemical reactions that take place as living things grow and die. Bacteria assist this process thereby hastening recycling.

Soil

- Subsoil or Horizon B: This soil has less air. As such it has few living organisms. It is not conducive to plant growth so few plant roots reach here. This soil is lighter in colour. Signs of human civilization, like a buried earthen ware, tools, and pieces of jewelry are often found in this layer.
- Horizon C: In this layer the soil is orange, yellowish or gray in colour. It is likely to be a mixture of sand, clay, pebbles and rock. It has hardly any living or remnants of living organisms. Digging further, one may hit the rocky bed which is the lowest layer.
- Soil profiles look different in different areas of the world. They are affected by climatic factors and vegetation. There is difference between soils that support extremely dense vegetation and very sparse vegetation. As rains and rivers wash down soil from mountains, the soil layers on their slopes become thinner and valley floors acquire thicker layers.



Soil types

- Sand, silt, and clay are the basic types of soil. Most soils are made up of a combination of the three. The texture of the soil, how it looks and feels, depends upon the amount of each one in that particular soil. The type of soil varies from place to place on our planet and can even vary from one place to another in your own backyard.
- In India, there are 17 soil types; some of these that are found in Maharashtra are described here.
- Red soil is deficient in nitrogen and organic matter; this soil is known to be less fertile. It is most suited for rice, ragi (millet), tobacco and vegetable cultivation.
- Laterite soil is poor in nitrogen it supports pastures and scrub forests. Though not suitable for agriculture, plantation crops such as tea, rubber, cinchona and coconut are grown on them along the west coast.
- Black soil is mainly derived from the basaltic rocks of the Deccan trap and occupy a large area in Maharashtra. High in moisture content they respond well to irrigation. Also known as 'black cotton soil' much of the country's cotton is grown in this fertile soil.
- An alluvial soil belongs to the major and most fertile soil group contributing the largest share to our agricultural wealth. This soil is derived from the deposition of soil sediments laid down by numerous river systems. Though deficient in nitrogen and organic matter, this soil is considered very good for **Rabi** and **Kharif** crops.
- Delta and Coastal soils are found at the mouth of the big rivers are swampy. They accumulate a lot of organic matter and support mangrove forests. Sea water inundates coastal areas regularly and the soils of these areas develop excess of salts and is known as saline soils.

Red soil

Laterite soil

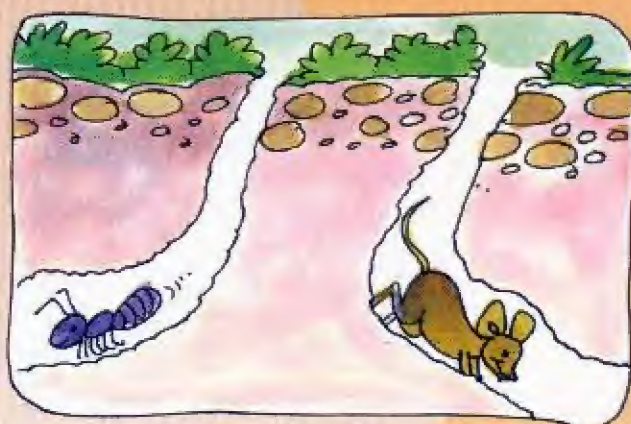
Black soil

Alluvial soil

Delta &
Coastal soil

Life in the soil

- Soil functions as an ecosystem in itself. Most soils are habitat for virus, bacteria, fungus, worms, insects, spiders, burrowing animals etc.
- Each organism in this ecosystem plays a vital role benefiting each other as well as the soil. In turn, the soil provides food, shelter and a breeding place for them.
- Nitrogen fixing bacteria present in the soil and on the **root nodules** of **legumes** recycle nitrogen from the air to the soil which can then be utilized by plants.
- Earthworms function as 'underground farmers', turning the soil over. They feed on decomposed organic matter and at the same time ingest large amounts of mineral particles. Their excrements in the form of casts is brought up and deposited on the surface. Because they migrate between the upper and lower layers of the soil, earthworms are important mixing agents in the soil. They also open up channels for air and water and so help to improve soil texture and related properties.
- Insects such as ants, termites, earwigs and rodents also help in **aeration** of the soil.



Case 2: Forest Story

Early European settlers in the tropical forests were convinced that the lushness of the "jungle" was due high amount of minerals and organic nutrients in the forest soils; so they cut down large patches of forest to create croplands. The cleared land supported vigorous agricultural growth, but only for one to four years and suddenly, plant growth declined to a point where large amounts of fertilizer were required for any growth at all.

Settlers wondered why their crops perished and how such poor soil could support the luxuriant growth of a tropical rainforest. The colonial settlers did not realize that they were dealing with an entirely different ecosystem from their temperate forests where most of the nutrients remain trapped in soil for a long time.

In the rainforest, most of the carbon and essential nutrients are locked up in the living vegetation, dead wood, and decaying leaves. As organic material decays, it is recycled so quickly that very few nutrients ever reach the soil.

Decaying matter is processed efficiently because of the abundance of decomposers including bacteria, fungi, and termites. These organisms take up nutrients, which are released as wastes when organisms die. As vegetation dies, the nutrients are rapidly broken down and almost immediately returned to the system as they are taken up by living plants.

Virtually all organic matter is processed rapidly, even fecal matter and perspiration. Insects are attracted to dung for the presence of nutrients like calcium salts. Human sweat is a treasure for several species of butterflies, which gather on the necks and hats of tourists, and for annoying sweat bees, which can cover seemingly every inch of exposed skin in some forests.



Soil

Land use patterns

- Land is the prime natural and economic resource which is utilized for agricultural as well as non-agricultural purposes.
- We derive our food, fuel wood, fiber, rubber and other raw materials from cultivated land. Land is a key resource for pastures and grazing lands. Forests that grow naturally on land give us timber, firewood, medicinal herbs and many other products.
- With growing urban populations, the demand for extending and creating new urban settlements and recreational areas has gone up significantly. Extensive land areas are also used for dumping waste generated by the city/town dwellers.
- With increase in volume of ground and air transportation more and more land is being acquired for extending roads, railways and airports and building new ones.



As the demand for food increases, vast tracts of forests are being converted to crop lands.

- Overstocking of livestock (cattle) is leading to extending pastures and also to overgrazing on open pastureland.
- Increase in consumer demands has led to an increase in product manufacturing and a fair chunk of land being used put to industrial use.
- While this kind of development is bound to put pressure on land and its natural resources. To retain some kind of balance we need to resort to practices that will sustain this resource and replenish the essentials it provides us with.

Case 3 : Jhum!

In the hilly slopes of India, the tribal farmers has little other option than to resort to shifting cultivation. The shifting cultivation is locally known as 'jhum' or 'jhum' in North-East India. The traditional "Jhum cultivation practice" involves burning of the forest on hill slopes followed by cultivation for a few years.

Jhum cultivation is harmful to the forest. In earlier times, jhum was within societies with negligible population pressure. The jhum field was allowed to lie uncultivated for long years; long enough to allow vegetation cover to regenerate before the cultivators returned that plot again and thus complete the jhum cycle. Such long cycles were ecologically healthy. This allowed the soil to regain its fertility. Current practices of jhum in the hills of north east India with short cycles are not ecologically healthy practices and have taken a toll on the vegetative cover of the hills.



Threats to soil

Improper land uses such as unsustainable agriculture practices, mining, deforestation, overgrazing gave rise to issues that affected the soil quality and texture. Some of the major threats such as soil erosion, drought, landslides, desertification and soil pollution are mentioned below.

Soil Erosion

Soil erosion is the loss of soil from the land. It is a process that is always occurring but it can happen faster if we continue to misuse the land. Wind and water are the main agents of soil erosion.

- Plants slow down water as it flows over the land (runoff) and this allows much of the rain to soak into the ground;
- Plant roots hold the soil in position and prevent it from being washed away;
- Plants in wetlands and on the banks of rivers are of particular importance as they slow down the flow of the water and their roots bind the soil, thus preventing erosion.
- The loss of protective vegetation through deforestation, over-grazing, ploughing and fire makes soil vulnerable to being swept away by wind and water. In addition, over-cultivation and compaction cause the soil to lose its structure and cohesion and it becomes more easily eroded.
- Erosion first removes the top-soil. Once this nutrient-rich layer of soil is gone, few plants will grow in the soil again. Without soil and plants the land becomes desert-like and unable to support life - this process is called desertification. It is very difficult and often impossible to restore desertified land.
- Soil erosion can be seen as both a symptom of underdevelopment (i.e. Poverty, inequality and exploitation), and as a cause of underdevelopment. A reduced ability to produce, invest one's profit and increase productivity, contributes to increasing poverty, and can lead to desertification, drought, floods, and famine.
- An array of damages caused due to soil erosion are:
- Loss of nutrient-rich top soil.
- **Siltation** of tanks or reservoirs resulting in shallow beds and reduced storage capacity.
- Lowering of the underground water table as the water **infiltrating** capacity is reduced due to loss of soil.



Soil



Did you know?

The FAO (Food and Agriculture Organization, a branch of United Nations) estimates that the global loss of productive land through erosion is 5-7 million ha/year.

In Maharashtra, over 70% of the cultivated land has been affected by erosion in varying degrees and 32% of the land have been highly eroded and is no longer cultivable!

More than 70% of Earth's dry land is affected by desertification. Desertification is devouring more than 20,000 square miles of land worldwide every year. Just 5,000 years ago, the Sahara was covered with grasses and shrubs.

Formation of Deserts

- **Desertification** is the process which turns productive land into non-productive desert as a result of poor land-management. Desertification occurs mainly in semi-arid areas (average annual rainfall less than 600 mm) bordering on deserts like Jaisalmer in Rajasthan.
- Desertification creates conditions that intensify wildfires and stirring winds, adding to the tremendous pressure to earth's most precious resource, water, and, of course, the animals' dependant on it.
- Climatic changes can trigger the desertification process, but human activities frequently are the proximate cause. Incorrect irrigation practices in arid areas can cause salinization, (the build up of salts in the soil) which can prevent plant growth.
- When the practices described above coincide with drought, the rate of desertification increases dramatically.
- Desertification reduces the ability of land to support life, affecting wild species, domestic animals, agricultural crops and people. The reduction in plant cover that accompanies desertification leads to accelerated soil erosion by wind and water.
- A reduction in plant cover also results in a reduction in the quantity of humus and plant nutrients in the soil, and plant production drops further. As protective plant cover disappears, floods become more frequent and more severe. Desertification is self-reinforcing, i.e. once the process has started, and conditions are set for continual deterioration.

Droughts

- In India some of the states are expected to face drought conditions once every four to five years. These are Rajasthan, Gujarat and Andhra Pradesh.
- Droughts lead to scarcity of food grains (akal), water (jalkal), fodder (tinkal) and often of all these (trikal). The subsequent famine leads to mass migration of humans and livestock.
- This year, 19 per cent of India's land area experienced 'moderate drought' ; 10 per cent suffered 'severe drought'
- During the drought of 2000-2001, a total of eight states had fallen foul of the rain gods. These included Gujarat, Madhya Pradesh, Orissa, Rajasthan, Chattisgarh, Himachal Pradesh, Maharashtra and Tehri Garhwal districts in Uttaranchal. Some states were in their second or third consecutive year of drought.
- In the 70 important water reservoirs in India, the storage position is officially described as the lowest in a decade. Ground water levels have fallen considerably in the eight drought hit states. In a number of districts, says the nodal agriculture ministry, the fall in water levels is at the rate of over 2 meters a year- this includes in Chattisgarh, Gujarat, Madhya Pradesh, Orissa and Rajasthan.

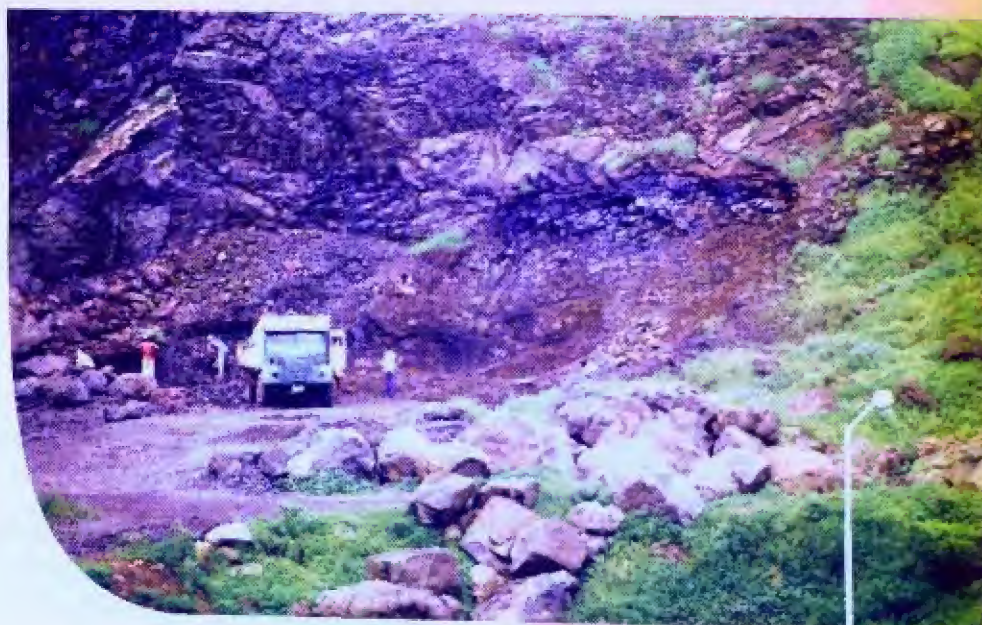


Did you know?

According to a UN study, about 30% of Earth's land - including the 70% of dry land - is affected by drought. Every day, about 33,000 people starve to death.

Landslides

- Slip erosion or landslides are more common in ghat areas. They are caused by the pressure of moisture that seeps deep into the soil during heavy rains.
- This water, when unable to move further because of hard soil or rocky strata below causes the big mass of overlying soil to move down and settle on low-lying land.



Soil

Case 4: The great deluge

- The coastal areas of Maharashtra were hit by the heaviest rainfall ever recorded in a period of 24 hours on 26 and 27 July 2005. Large number of families in Maharashtra, were affected by the resulting floods and landslides and the release of water from dams. Landslides were reported to have occurred near Sakinaka (Andheri, Mumbai), claiming 90 lives and burying 35 houses. In Jui Village of Mahad (Raigad District) 100-150 person were reported to have been buried under debris. The flood waters retreated, but overflowing dams, lack of clean water and rotting garbage posed a range of health problems to the residents in these areas.
- Preliminary reports estimated more than 10, 000 house collapses in the affected districts of Mumbai, Sindhudurg, Sangli, Ratnagiri and Raigad
- Civic infrastructure like roads, public buildings (primary health centers, schools and administrative buildings) and water supply schemes were damaged.
- Health services were affected in Ratnagiri, Raigad, Thane and Mumbai suburban areas.
- This incident proved to be a rude awakening to the collapsing infrastructure of the state. Improper solid waste management and age-old drainage systems brought a buzzing city like Mumbai to a dead halt.
- Situation also got aggravated due to the illegal diversion of the Mithi river that flows through the city. Another aspect was that of mindless concretization of roads and lack of open ground due to which the water accumulated during the down pour had little chance to seep into the soil.

Soil pollution

- Waste dumped in the soil which is beyond the assimilative capacity of the soil, results in pollution of the soil.
- Urban solid waste with non-biodegradable material causes degeneration of soil quality. Harmful chemicals that leach from this waste seep into soil and lead to contamination of ground water.
- Careless disposal of industrial waste releases hazardous chemicals into the soil, resulting in crop damage.
- Mining for various minerals may lead to leaching of harmful elements into the ground water resulting into diseases and deformities.
- The pollutants in the soil travel across the food chain. As they reach higher levels, they get more concentrated and eventually affect human health.
- Increased salinity levels in the soil are not good for earthworms therefore more and more city soils are losing their earthworms.



Soil conservation

- Soil being one of the most important resources for our survival, it is our responsibility to retain its health and quality.
- Soil is widely used in agriculture and our farmers are aware of a wide variety of traditional farming practices such as using nutrient-rich tank silt, penning livestock in the cultivated field, using weeds or water hyacinths for manure. Such ecological farming systems, which combine highly efficient methods of organic recycling and crop protection using indigenous practices, need to be revived. A brief of the same is given below:

Strip cropping

Strip cropping consists of growing crops that do not hold soil (Sorghum, maize) and crops that hold soil to their roots (ground nut, black gram) in alternate strips. The soil which flows from the erosion permitting crop strips is caught by the alternating strips of erosion resisting crops.

Mulching

Mulch is natural or artificially applied layer of plant residues or other materials on the surface of the soil. Mulching (e.g. Jowar or Bajra stubbles, paddy straw or husk, sawdust) reduces soil loss considerably by protecting the soil from direct impact of raindrop and reduces soil runoff.

Crop rotation

If a set of crops (e.g. Jowar or Bajra) is grown continuously over the same field within a specified period of time it leads to loss of soil fertility and erosion, but if followed by a legume crop namely Hulga, Matki or Gram these problems can be controlled.

Contour cultivation

In **contour** ploughing or contour farming ploughing is done across a slope in contours. The cultivated land on the mountain slope is ploughed perpendicularly (rather than parallel) to the sloping land, all along the periphery. The plowed rows slow the water run-off during rainstorms so that the soil is not washed away and allows the water to percolate into the earth. This forms furrows around the land. Contour farming can reduce soil erosion by 50%.

Afforestation

Tree plantation increases the infiltration capacity and water holding capacity of soil. Trees also act as wind breakers reducing the impact of strong winds and so controlling soil erosion. Tree roots also hold the soil together. In the coastal districts of Maharashtra, which receive more than 1250mm rainfall, cashew nut plantation has been successfully undertaken on hills slopes, to reduce erosion.

Block bunding

Bunds are constructed of mud or stone or both to impound water and arrest soil washed from the blocks.

Terracing

This is suitable for slopes and areas with rainfall higher than 1250mm. **Terrace bunds** are constructed at intervals across the slope. The vertical spacing between bunds may vary from 1 to 2 m, depending upon the slope, types of soil, rainfall. E.g. Bench terracing is done in steeper slopes as in hilly ranges of Himalayas and Sahyadris. The terraces are in the form of sloping table tops.



Soil

Case 5: Restoration project in a semi-arid area

Ecological Society-a Non Governmental Organisation in Pune has been successful in its soil restoration project at Phaltan. The soil on a 20 acre area near Vinchurni village, of Phaltan taluka in Satara district of Maharashtra, has recuperated over a period of 3 years. The project site was a semi-arid zone in a **rain shadow region** with an average annual rainfall of below 200mm. The soil had lost its top soil cover and had got extensively degraded due to overgrazing.



The site was given protection with electric fencing and agricultural biomass was spread over the land. Gradually the soil started enriching, and healthy vegetation germinated. It was also observed that the annual grasses were replaced by the perennial varieties of high nutritive value. The change in the vegetation also attracted animal life which contributed in seed dispersal and pollination. At present the project site stands green surrounded by vast barren land. The revitalized site also withstood the drought period 3 years ago. Considering the fact that the area started with one of its goals to conserve the top soil it eventually resulted the regeneration of the complete ecosystem. The ultimate goal of this project was to make the local people realize the significance of their resources and how efficiently they can reap its benefits by conserving them.

How can we help?

- In cities, citizens should ensure that their housing localities have enough open ground so that the run off water gets an opportunity to percolate into the ground and charge our aquifers.
- Major cities such as Mumbai, carries out major concretization of roads and pathways as a result the rainwater has to come down gushing into our drains and thus flooding them. We should limit concretization to main roads and flyovers and keep enough open ground.
- Solid waste from urban areas should be segregated into **bio-degradable** and non-biodegradable waste at the point of generation.
- Biodegradable waste can be used in **vermicomposting** or biogas generation.
- Non-biodegradable waste such as plastic, glass, metal can be given for recycling.
- Radioactive waste should be disposed with utmost care deep in the ground after packing in radiation proof containers.
- Biological pest controllers should be used instead of pesticides in our fields and gardens.



GLOSSARY:

Aeration:	To expose to air circulation for purification
Biodegradable:	Matter that will break down both physically and chemically in an environment in a natural process.
Contour:	Undulating edge of the land.
Creek:	Tidal inlet, which forms salt marshes and swamps, when the water drains out.
Desertification:	State of the land wherein it is rendered unproductive/ arid due to climatic variations and human activities.
Infiltration:	Moving in, entering
Kharif:	Summer crop
Legumes:	Pods that split into two valves eg. peas
Quarry:	Open excavation pit from where stone is obtained.
Rabi:	Winter crop
Rain shadow region:	Area with relatively little precipitation due to the effect of a barrier, such as a mountain range, that causes the prevailing winds to lose their moisture before reaching it.
Reclaimed:	Prepared for cultivation or habitation by filling , irrigating , fertilizing land.
Root nodules:	Localized outgrowth on the roots that help in nitrogen fixation.
Siltation:	To be filled covered up with silt.
Terrace bunds:	Raised bank of earth having vertical or sloping sides and a flat top with raised borders called "bunds".
Vermi-composting:	Method in which earthworms are introduced to organic waste to turn it into very high quality manure

Thoughts on nature

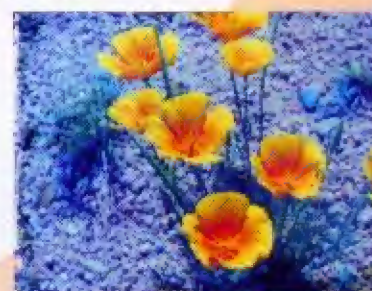


• *Climb the mountains and get their good tidings. Nature's peace will flow into you as sunshine flows into trees. The winds will blow their own freshness into you, and the storms their energy, while care will drop away from you like the leaves of Autumn.*

John Muir

• *If you wish your children to think deep thoughts, to know the holiest emotions, take them to the woods and hills, and give them the freedom of the meadows; the hills purify those who walk upon them.*

Richard Jefferies



Soil



ACTIVITIES



ACTIVITY 1: How many animals live in soil?

Objective: To study about the Soil fauna.

Background: Knowledge about soil fauna and their importance in maintaining the health of soil.

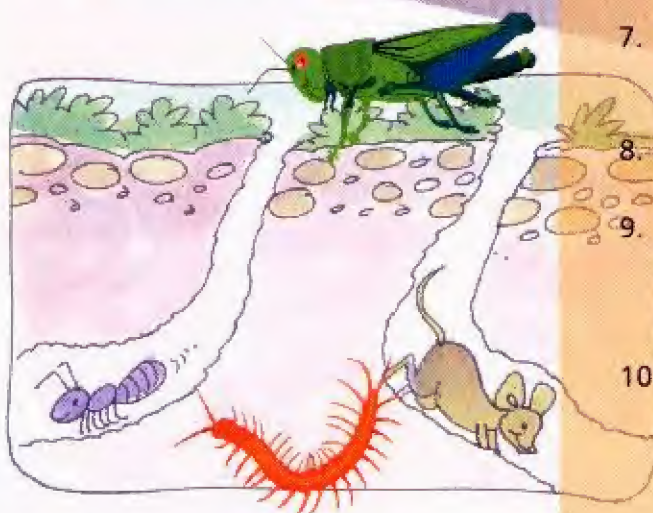
Subjects covered: Science.

Approach: Fieldwork and observation.

Materials required: Soil samples from various places, funnel, and transparent jars (one for each type of soil).

Method:

1. Ask the children to collect soil from different places in individual jars.
2. Ensure to keep the funnel above the jar and remove unwanted things like stones or plastics etc.
3. The soil should be added in heaps so that vacuum pressure blocks the entrance of the funnel.
4. Instruct to wrap the jar from outside with a thick dark cloth so that the light does not reach inside the jar.
5. After reaching classroom, keep the jar along with the funnel in sunny place so that the organisms in the soil start moving down.
6. After few hours the funnel can be removed from the jar top. Ask children to observe and write about the animals they see crawling within the jar.
7. Mostly the soil fauna includes of woodlouse, earwigs, millipede, field cricket, field cockroach and ants.
8. Help the children to identify and describe the soil animals with help of a picture chart.
9. Discuss the lifecycle of various animals that pass through soil, the other various micro-organisms that are present in the soil, the role of these animals in maintenance of soil.
10. Encourage children to carry out similar activity around their homes and inform them that the higher diversity in soil fauna indicates healthy soil.





ACTIVITIES



ACTIVITY 2: How good is soil in the fields?

Objective: To enable children to identify different types of agricultural lands and study the soil in terms of physical characters such as colour, texture, and moisture land is used.

Background: Knowledge of types of agricultural fields, crops and favourable soil.

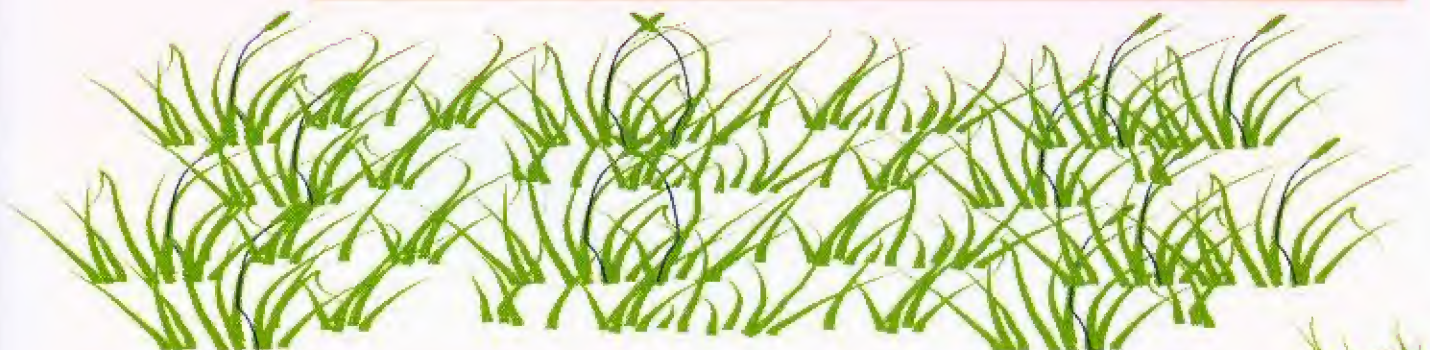
Subjects covered: Science, Social Studies and Language.

Approach: Learning by Survey and Communication.

Materials required: Paper and pen/pencil.

Method:

1. Take the children for a walk in the nearby agricultural fields.
2. Make them notice the difference in the agricultural field as the crops differ, ask them to note down different crops grown in different fields, and character of such fields in terms of water availability, sunlight, temperature, altitude etc.
3. Ask them to note down texture, colour, and moisture and if possible the pH of the soil samples of the different crop fields they visit.
4. Instruct the children to interact with the farmers to know more about the cultivation practices.
5. Help them to put together a list of questions. A sample is given below.
 - What makes them decide what needs to be grown and where?
 - What is the ideal crop that should be cultivated at the present time of visit?
 - What are the different crops that can be grown and what are the field requirements for them?
 - Whether they use chemical pesticides and fertilizers? Or do they practice organic farming?
 - Do they realize the need of hedges around the fields?
 - What kind of wildlife frequents their fields?
 - What are their agriculture related concerns?
6. Split the groups. Five children can perform the task of interviewing one elder and recording the answers.
7. Generate a discussion on different types of cultivation practices in Maharashtra and how the soil factors affect it.





ACTIVITIES



ACTIVITY 3: How much water your soil can hold?

Objective: To make children learn about water holding capacity of the soil and how plants help in increasing the same and reducing soil erosion.

Background: Explain the concept of soil erosion, role of plants in conserving soil quality and increasing its efficiency and water holding capacity.

Subjects covered: Science and Social Sciences.

Approach: Experiment and observations.

Materials required: Two earthen pots, soil, measuring cylinder, plant sapling, seeds of wheat or peas.

Activity:

1. Instruct the children to get three earthen pots of equal size and weight and label the pots as A, B, and C.
2. Ask children to put equal amount of loose soil in the pots.
3. Ask the children to get a small sapling and plant in the pot B in such a way that the quantity of the soil is not changed, in the pot C instruct to sow the seeds and nothing will be added in pot A. Sprinkle water on all the pots.
4. After two or three days keep all the three pots in three different trays and pour calculated amount of water, say one liter in all the three pots and collect the drained water from the down holes of the pots in to the trays, measure the amount of water collected in the tray, also notice the soil coming out along with the water, this is soil erosion.
5. Find the amount of water drained out with the help of measuring cylinder, subtract the amount of water coming from each pot from the amount of water poured; the difference in the two is water holding capacity. Find out the water holding capacity of each pot. Less the water is drained more is the water holding capacity.
6. Instruct the children to note down water holding capacity of each pot, and colour of the water collected in the tray, the darker the water the more is the soil erosion.
7. It would be observed that since pot-B had a sapling had higher water and soil holding compare to pot C which had sprouting seeds and pot A which had nothing to hold on. Thus the soil erosion was 'highest' in pot A, 'moderate' in pot B and 'least' in pot C.
8. The activity could be repeated after few days when the water holding capacity of the planted pots would increase gradually with decrease in soil erosion while unplanted pot A will remain the same.
9. Same activity can be done with no plants and only soil of different types for different water holding capacities.
10. Encourage children to carry out similar activity for the garden plants and look for differences in the water holding capacity.





ACTIVITIES

ACTIVITY 4: What is the soil composed of?

Objective: To enable children to identify different type's particle that together constitute soil and.

Background: Knowledge of soil composition and process of soil formation.

Subjects covered: Science and Mathematics.

Approach: Learning by experiment and calculation.

Materials required: Dry soil, sieves with different size of mesh, paper and pen/pencil.

Method:

1. Ask children to collect 1 kg of soil from any nearby excavated area and make it dry for a day.
2. Now ask children to bring at least 3 sieves having pores of different sizes i.e. one that is used for sieving very minute powder particles, second one with pores little bigger and third with big pores that is used to sieve wheat or rice. Label these sieves as per their mesh sizes from smallest to largest mesh as 1, 2 and 3.
3. Instruct that the sieved contents from each sieve should be collected on individual paper. 3. Ask children to take the 1 kg of soil in to the sieve-1 and sieve the soil.
4. Change the left over soil to sieve-2 and sieve it. Finally add the remains to sieve-3 and then empty the left over on a paper.
5. Make children weigh and feel the texture of the soil particles collected from different sieves and note down the weight of the particles from each sieve.
6. Tell the children to find out the percentage of the four separated particles in each sample of the soil.
7. It would be observed that the soil had mixture of fine to coarse particles including stones and softer detritus particles. Inform children that the quantity of each of the components signify fertility of the soil e.g. soil with highest detritus is very fertile and vice versa.
8. Make children to repeat the activity with soil samples from different areas and compare the readings.





ACTIVITIES

ACTIVITY 5: How land is used in your area?

Objective: Mapping land use and studying land use management practices.

Background: Knowledge about land use practices/patterns in India/Maharashtra.

Subjects covered: Science and Social Sciences.

Approach: Learning by survey

Materials required: Map of the local area, datasheet, and pen/pencil.

Method:

- 1 Get your locality map and explain children they need map the land usage by visiting different sites of the locality.
- 2 Divide the class into four groups; assign each zone i.e. East, West, North and South to each group.
- 3 Ask each group to mark following items on their map; educational institutions, residential areas, industrial units, markets, gardens, fields, hospitals, office premises, waste land, garbage dumping site, construction areas, roads, flyovers, airport, railway station, rickshaw or taxi stand, bus depot etc.
- 4 Instruct them to fill up required numbers in their data in the data sheet that could be prepared as per the sample given below.
- 5 Also ask them comment on the alternative use of the land in terms of available resources.
- 6 Collate the children's data into following format and arrive at conclusions.
- 7 Hold a discussion and observation and findings e.g. if there are more agricultural lands and less industries, find out is there an issue of poverty and unemployment, or if there are more industries, is there an issue of bad health and pollution.
- 8 Encourage children to redesign their locality map with their ideas which would benefit both people and environment.

Land use items	East	West	North	South	Comments
Educational Institution					
Residential Area					
Industrial Units					
Markets					
Gardens					
Hospitals					
Office Premises					
Waste Land					
Garbage Dumping Site					

Soil



ACTIVITIES

ACTIVITY 6: Are you aware of soil problems in your area?

Objective: To find out the various soil problems in the area and make people aware about them through campaigns.

Background: Knowledge of soil threats.

Subjects covered: Science, Social Sciences and Language.

Approach: Learning by survey and campaigns

Materials required: Posters, chart paper, colours, pen/pencil.

Method:

- 1 Explain to the children the various possible areas where soil as a resource is wasted, misused, damaged or polluted. Provide them with a checklist of the same.
- 2 Ask the children to go in the neighborhood areas and find out the various soil problems that they come across
- 3 Next day tell them to prepare posters of various soil problems that they saw in their survey like places where they spotted soil erosion, or places where they notice plastics and all kinds of non-degradable waste dumped etc. Also help them to prepare soil conservation message charts.
- 4 Take children for campaign to the nearby areas along with the posters and slogans on it, ask them to talk to people there and find out what they think about this unnoticed problem.
- 5 Generate a discussion among children the need to spread awareness so that our nature can be protected.
- 6 Write to the concerned authority for initiation of soil restoration programmes.

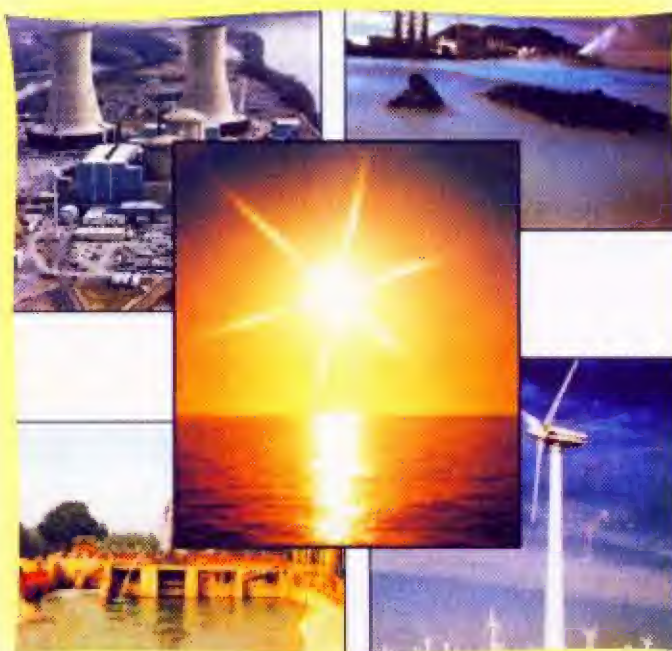


Energy

I have no doubt that we will be successful in harnessing the sun's energy.... If sunbeams were weapons of war, we would have had solar energy centuries ago.

Sir George Porter

Agni- the last element of nature is signified by the sun. Sun-the centre of the universe has intrigued humans for hundreds of years by the sheer power it exudes of making and destroying life. This chapter deals with sun-power that makes the world move.



Energy facts

- India consumes 15% of the world's energy.
- Coal remains the primary fuel in India's energy profile, accounting for more than half of total energy consumption in 2010.
- The household sector is the largest consumer of energy in India, accounting for 40-50-% of the total energy consumption. Only 55% households of India have access to electricity.
- The bulk of energy consumed by households consists of traditional fuels such as firewood, animal dung and agricultural residues. The heavy dependency on traditional fuels has led to several health and ecological problems.
- Urban Indians purchase 14-20 million tonnes of firewood every year, worth Rs. 500 crores--this is more money than the government spent on **afforestation** in the 30 years from 1950-1980.
- The intensity of energy extraction, production and use of these resources has resulted in the destruction of the environment through pollution.
- The consumption rate of these resources is twice their production.

- The non-commercial energy sources are: solar, wind, tidal and geothermal energy. These non-conventional energy sources are perennial and eco-friendly.
- India is the only country that has an independent ministry to look after renewable and non-conventional energy resources, and has one of the largest national programs to promote the use of solar energy.
- India is considered as the world leader in renewable energy.
- India ranks first in the use of solar cookers (4.6 lakh) and biomass (28 mw).



Sources of energy

- In nature energy is stored in different forms and sources. These sources are mainly of two types; Non-renewable and renewable.
- *Non-renewable* energy cannot be recreated in a short period of time e.g. fossil fuels and nuclear energy.

Fossil fuels :oil, natural gas and coal

- A major source of energy that is found deep in the ground. Fossil fuels are so called because they were formed over millions of years by the action of heat from the earth's core and pressure from rocks and soil on the remains of the dead plants and animals.
- If we exhaust our deposits of fossil fuels and are not ready with alternate energy sources we are likely to face an energy crunch that may lead to a major calamity.
- Oil is composed mainly of mixtures of chemical compounds of carbon and hydrogen. It is found deep in the ground usually between layers of rock.
- To get the oil out, a hole is drilled to the deposit and the oil then pumped out of the ground. It is then carried in pipelines or by large tankers, to be refined.
- A refinery changes oil into products like petrol, jet fuel, diesel fuel and other products by the process of fractional distillation.
- Natural gas is lighter than air. It is made of methane and is highly inflammable. From deep in the Earth, this gas rises towards the surface and builds up in pockets as its progress is blocked by solid rock.
- It is pumped out from the ground and sent through underground pipes to homes and factories. CNG (Compressed Natural Gas) is also used as a fuel for vehicles.
- Coal is a readily combustible sediment rock extracted from the ground by mining. It is then transported for use in thermal power stations where heat obtained by burning it is used to convert water into steam, which rotates the **turbines** to generate electricity.
- Coal is also used in factory furnaces and kilns. It was once a major fuel for home consumption.



Energy

Nuclear Energy

- Nuclear energy is the energy that comes from splitting atoms of radioactive materials such as uranium. Uranium occurs naturally in many parts of the world in rocks or sand deposits and can be mined from the surface or underground mines.
- In this process an immense amount of energy is produced, which can be used to produce electricity. It gives more energy than any other source. Pollution due to emission of gases like CO_2 , CO , SO_2 which occurs in thermal power plants is absent.
- Nuclear power plants and radioactive pollution go hand in hand. There are radiation risks involved from processing uranium. These radiations are **detrimental** to health and can cause permanent changes in the genes of body cells. Accidents due to negligence can be catastrophic.
- The Atomic Energy Commission oversees India's nuclear power industry. India has 14 nuclear reactor units in operation at Tarapur in Maharashtra, Kalpakkam in Tamil Nadu and Rawatbhata in Rajasthan with a combined generating capacity of 2,720 megawatts and a 235 MW unit at Narora (Uttar Pradesh). All are operated by the government's Nuclear Power Corporation of India Ltd. (NPCIL). NPCIL wants to boost its capacity to 7,300 MW by 2007 and by 2020 to 20,000 MW.
- Hydrogen is high in energy; an engine that burns pure hydrogen produces almost no pollution. NASA has used liquid hydrogen since the 1970s to propel its space shuttles and other rockets into orbit. Hydrogen fuel cells power the shuttle's electrical systems but produces a clean by product pure water, which the crew consumes. Some experts think that hydrogen will form the basic energy infrastructure that will power future societies, replacing today's natural gas, oil, coal, and electricity infrastructures.



Fuel	Amount	Electricity generated
Coal	500 gms	1.5 kilowatt hours
Oil	500 gms	2.0 kilowatt hours
Uranium	500 gms	300,00 kilowatt hours

- *Renewable sources of energy* are those that could be replenished in a relatively short period of time. They include solar energy, wind energy, geothermal energy, biomass and ocean energy.
- When compared with fossil fuels Renewable energy sources are:
 - clean sources of energy as they are emission free
 - inexhaustible in supply
 - used in fully automated systems
- Energy generated from fossil fuels are:
 - highly location specific as the sources are available in some parts of the country during some months only
 - can supply the needs of only a small area
 - expensive as initial investment is high
 - have a storage problem.



Sr.No.	Source	Potential MW	Achievement in MW
1	Wind	3650	401.355
2	Small Hydro	599.47	206.33
3	Bagasse cogeneration	1000	32.5
4	Biomass	781	6
5	Municipal Solid Waste	100	0
6	Industrial Waste	350	6.126
	Total	6480.47	652.311

Sun power

- Despite a trend towards urbanization, more than 70% of India's population still lives in rural areas.
- Renewable energy projects are the key to providing rural areas with energy where power is in short supply.
- India is the only country that has a separate government ministry exclusively for non-conventional energy sources,
- Most of the developed countries have turned to solar energy mainly out of concern about the environment and energy security, but the use of solar power in India is being advocated as a way to provide energy to regions where there is a shortage of electricity. In many small villages and remote areas, solar photovoltaic systems are far more cost-effective than conventional energy.
- India is rich in wind energy potential, and the country has been adding installed wind power capacity at an impressive rate.
- According to the Ministry of Non-Conventional Energy Sources, India now expects to exceed its target of installing 1,500 MW of wind power in the 2002-2007 period.



Renewable Energy Potential in India

Source / Technology	Potential Availability	Potential exploited
Biogas Plants	12 Million	2 Million
Biomass-based power	17,000 MW	Marginal
Efficient Woodstoves	120 Million	18.5 Million
Solar Energy	5×10^{15} Whr / Year	-
Small Hydro	10,000 MW	250 MW
Wind Energy	20,000 MW	250 MW
Ocean Thermal	50,000 MW	-
Sea Wave Power	20,000 MW	-
Tidal Power	9,000 MW	-

Source: National Paper on Energy Scenario in India, 1995, India Member Committee, World Energy Council

Energy

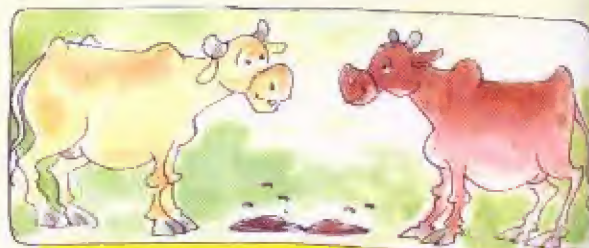
Solar Energy

- Solar energy is generated by trapping the sun's heat by using solar panels to heat water, or converted to electricity by means of photovoltaic cells.
- India receives about 6000 billion MW of solar energy per year. If only one percent of this energy could be tapped at even 10 percent efficiency, it would be about 30 to 35 times India's present electricity generation.
- It is the most readily available, non-polluting source of energy. It does not belong to anybody and is therefore free.
- Solar Energy is used for Cooking, Heating, Drying, Timber seasoning, Distillation, Domestic lighting, Street lighting, Village electrification, Water pumping, Desalination of salty water, Powering of remote telecommunication stations, Railway signals, solar cooker, solar air driers, solar timber kilns, solar calculators and solar lights.



Biomass

- Biomass is organic waste material made up of plant and animal material such as example agricultural waste products and animal droppings used as a source for fuel.
- In India, 5,000,000 tonnes of animal dung cakes are burnt as fuel every year.
- Our forests are being severely depleted due to the increasing demand of fuel wood. In India it is estimated that of the 683 lakh tonnes of carbon is released annually due to biomass burning, of which burning of fuel wood accounts for 82.3 %.



Did you know? this is source of biogas

- With domestic households as well as rural industries using increasing quantities of fuel wood, this situation could only worsen in the future.
- Biomass could be used to produce fuels such as:

Biogas: Animal and human excreta is used to produce methane gas, which can be used for cooking and the residual dung is used as manure.

Bagasse: Fermented bagasse (crushed sugarcane) produces ethanol, which is used as fuel.

Biomass gasifier: It is a device which converts solid biomass such as wood, agricultural residues e.g. rice husk, leaves, sticks, coconut shells and weeds such as lantana into combustible gas mixture, which contains mainly carbon monoxide and hydrogen as combustible gases. These gases are then used for mechanical and thermal operations such as operating engines for pumping water, cooking, and generation of electricity.

The advantages of using biomass are:

- It is an easily renewable source
- It reduces the amount of waste going into landfills
- It is free from carbon dioxide emissions
- It can be compressed into blocks. This increases its use in chullahs, furnaces and gasifiers.



Case 1: Bio-energy!!!

An energy self-sufficient taluka model was developed by NARI (Nimbkar Agricultural Research Institute) in Phaltan taluka in Maharashtra. It was found that Phaltan taluka would require about 13×10^8 MJ (**Mega Joules** = 10,00,000 Joules) of electricity and about 2.6 crore litres of petroleum products (diesel, petrol and kerosene).

It was established that all this energy could easily be produced by biomass resources produced in the taluka through biomass based power plants (i.e. production of ethanol from sweet sorghum), existing distilleries, pyrolytic oil production from agricultural residues and energy plantations. Electricity from biomass-based power plants would replace electricity supplied by the Maharashtra State Electricity Board, while ethanol and pyrolytic oil would replace liquid petroleum products. The NARI study also showed that with the capital input of Rs. 300 crores, a Phaltan taluka model can produce wealth of Rs. 220 crores per year and provide employment to 30,000 people year-round.

Case 2: Grow your own fuel

Jatropha curcas or Jatropa, is a low growing tree that is native to South America, but widely planted in South and Central America, Africa and Asia. Till now it has been used for its medicinal, pest repellents and erosion control properties but recently it has been also used to ease our fuel issues. *Jatropha* seeds can be used in preparation of bio diesel. Nearly 31 to 37 % of oil is extracted from a *Jatropha* seed. It is indeed the new bio-diesel that could replace diesel.



Energy from the ocean

Tidal energy

- Tides are a source of energy. The difference in height between the high tide and low tide is large and can be used to turn the turbines.
- The simplest generation system for tidal plants involves the construction of a dam, known as a barrage, across the tidal inlet. The gates on the barrage allow the basin to fill with incoming high tides and to empty through the turbine system with the outgoing tide. There are two-way systems that generate electricity on both the incoming and outgoing tides.
- The first tidal energy plant was set up on River Rance in France. In India investigations on the use of tidal power have been carried out in the National Institute of Oceanography, Goa, the Gulf of Kutch and the Gulf of Cambay on the west coast and the Sunderbans on the east coast.

Energy



Wave energy

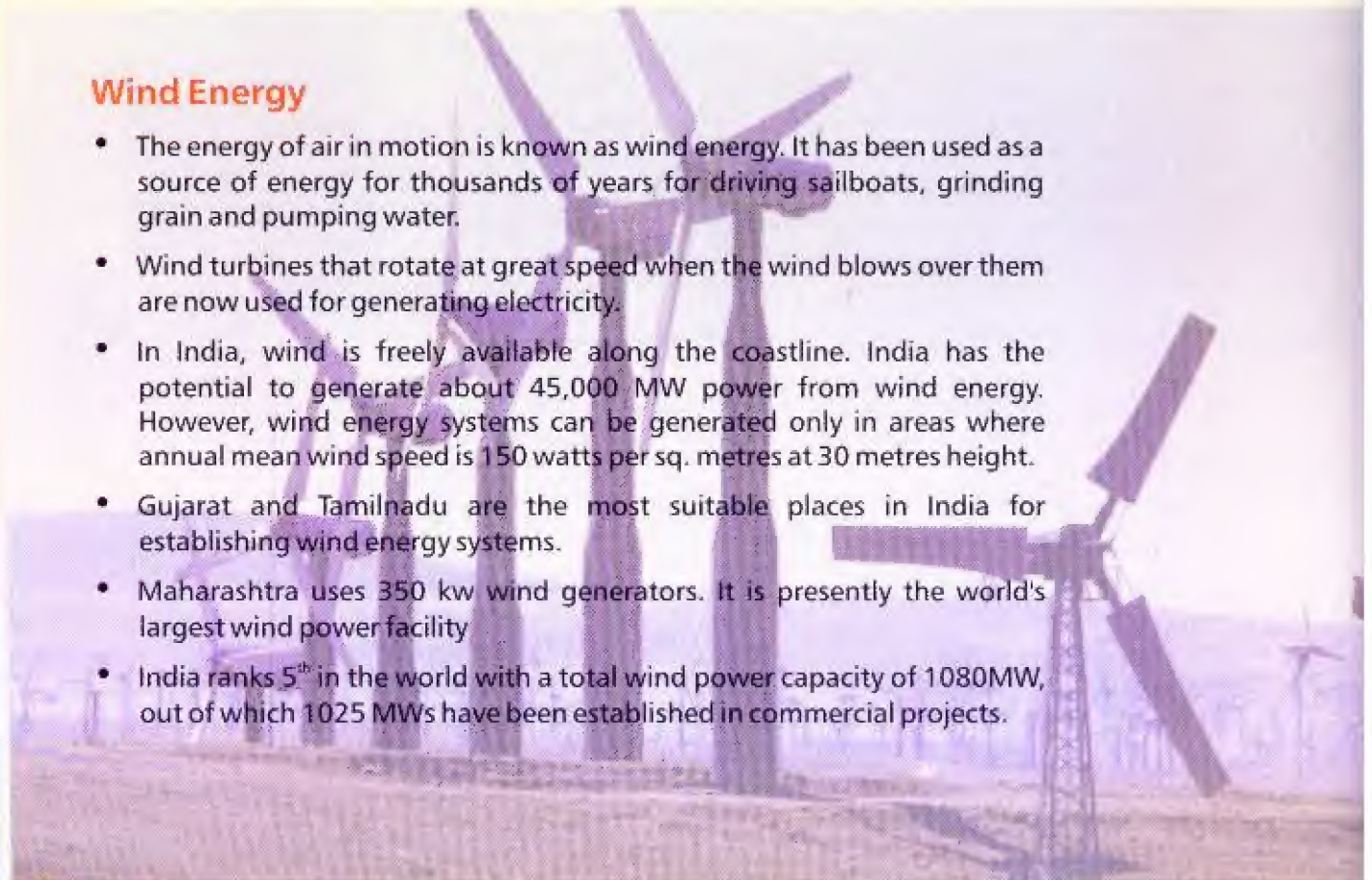
- There is tremendous energy in ocean waves.
- One way to harness wave energy is to bend or focus the waves into a narrow channel, increasing their power and size. The waves can then be channeled into a catch basin or used directly to spin turbines.

Hydroelectric Energy

- Energy in flowing water could be used to produce electricity. Water descending rapidly from a very high point, flows through a narrow path or pipe, and pushes against a turbine. This turns the blades in a turbine and spins it. The turbines are connected to generators which produce electrical energy.
- The water stored in the reservoir of a dam possesses potential energy, which could be converted into electrical energy, when the stored water is released.
- Hydroelectric power is the world's second largest source of electricity. It supplies about 16% of India's conventional energy and 28% of its electricity. It is however heavily dependant on rains.
- The dams constructed for harvesting hydroelectric energy often flood good farmland and forests and leads to displacement of people. They also result in the spread of waterborne diseases

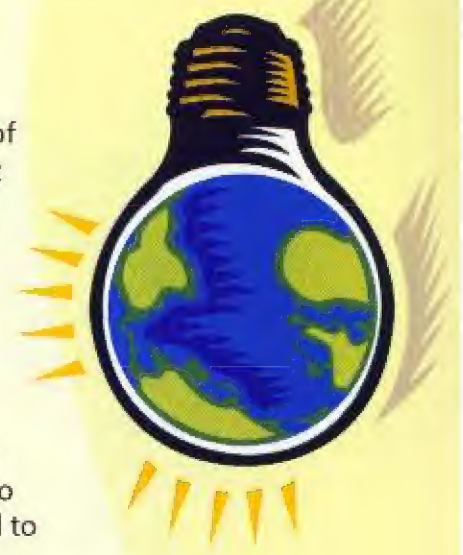
Wind Energy

- The energy of air in motion is known as wind energy. It has been used as a source of energy for thousands of years for driving sailboats, grinding grain and pumping water.
- Wind turbines that rotate at great speed when the wind blows over them are now used for generating electricity.
- In India, wind is freely available along the coastline. India has the potential to generate about 45,000 MW power from wind energy. However, wind energy systems can be generated only in areas where annual mean wind speed is 150 watts per sq. metres at 30 metres height.
- Gujarat and Tamilnadu are the most suitable places in India for establishing wind energy systems.
- Maharashtra uses 350 kw wind generators. It is presently the world's largest wind power facility
- India ranks 5th in the world with a total wind power capacity of 1080MW, out of which 1025 MWs have been established in commercial projects.



Geothermal Energy

- For every 100 metres that one goes below ground, the temperature of the rock inside the earth increases by about 3°C. So, if one goes about 10,000 feet below ground, the temperature of the rock would be hot enough to boil water. This heat energy is known as geothermal energy.
- This heat is brought to the near-surface by thermal conduction and by intrusion into the Earth's crust of molten magma from great depth.
- Geothermal energy can be produced from hot water and steam, as the groundwater gets heated. The steam and hot water are used to run turbines and generate electricity. Geothermal heat energy is used to heat houses and offices in the Puga valley in Ladakh region.
- There are seven main geothermal regions in India, which contain a total of about 400 thermal springs. Of these a major one is Son-Narmada-Tapi rift zone, which follows the Narmada river valley from Gujarat into Madhya Pradesh and then continues into Eastern India.



Human And Animal Energy

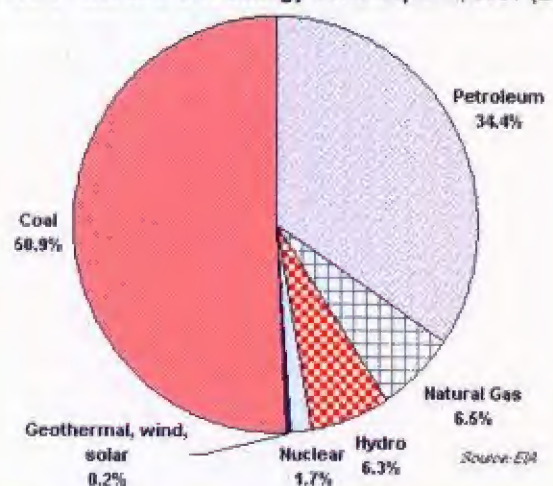
Over half of all the energy on India's farms comes from the muscles of hardworking animals.

India has 80 million work animals- bullocks, horses, camels, donkeys, elephants and yaks. If each of these animals generates 0.5 HP (horse power), the installed capacity of animal muscle force comes to 40,000 HP or about 30,000 MW which is equal to the installed capacity of electrical power generation in India.

Energy consumption

- India's energy consumption is increasing rapidly, from 4.16 quadrillion Btu (quads) in 1980 to 12.8 quads in 2001. This 208% increase is largely the result of India's increasing population and the rapid urbanization of the country.
- Higher energy consumption in the industrial, transportation, and residential sectors continues to drive India's energy usage upwards at a faster rate even than China.
- These statistics are closely tied to India's economic transition from agriculture to industry and to the general increase in the standard of living and shift towards a more Westernised pattern consumption. Furthermore, government subsidies keep the price of diesel fuel at a relatively low and stable real (adjusted for inflation) price. Because of these subsidies, there is little incentive for many truck owners to curtail their fuel consumption.
- In 2002, India accepted the Kyoto Protocol that mandates by countries to reduce their emissions of greenhouse gases by an average of 5.2% below 1990 levels by the agreed 2008-2012 time frame.

India's Fuel Share of Energy Consumption, 2001 (Btu)



Energy

- India's heavy reliance on low quality coal is responsible for its relatively high carbon intensity level. Indian economic policies such as high import tariffs on high-quality coal and subsidies on low-quality domestic coal also have contributed to increased use of low-quality coal, although initiatives to encourage the use of higher-quality coal, such as reducing the tariff on imported coal, may help in reducing the country's carbon intensity.
- The introduction and adoption of technologies to reduce coal consumption and/or improve the efficiency of the coal that is combusted is an important government priority, given that the majority of India's power generation is coal-fired.

Saving energy

- We buy energy, sell energy, eat energy, fight over energy, even waste energy, but we hardly talk about conserving energy. The ill effects of over consumption of energy are slowly becoming more evident.
- People have, however, begun to realize the importance of energy conservation and are making a conscious effort towards its sustainable use. It is imperative that a balance between natural resources and the population be maintained in order to ensure the continuity of the human race.
- A practical way of solving our energy problems is to use alternative renewable sources of energy. Though there are some constraints and difficulties in tapping renewable energy sources, efforts are being made to make use of them as they reduce dependence on non-renewable sources of energy.

Case 3: Energy Conservation in Maharashtra

The Maharashtra Energy Development Agency (MEDA) in Maharashtra is established for promotion and development of Non-conventional and Renewable Source of Energy (NRSE) systems and devices. Under the NRSE programme, various NRSE systems are distributed on a subsidized rate or on soft term loans.

The Integrated Rural Energy Planning is a programme sponsored by the Ministry of Non-conventional Energy Sources, Government of India, which was implemented in 37 blocks of 30 districts in the state. This programme is aimed at fulfilling the energy requirements in rural areas with the support of locally available resources. This also helps in improving the hygiene and living conditions of the rural masses.

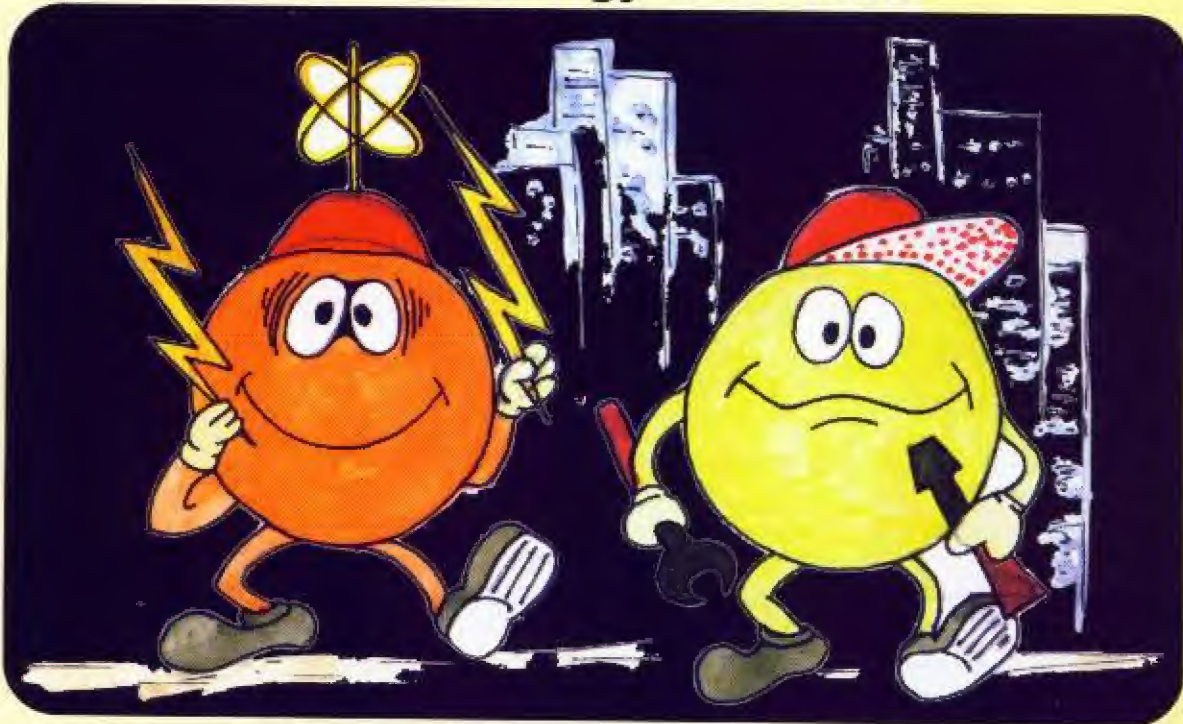
The Tribal Sub Plan is being implemented in selected areas of 48 talukas of 12 districts. Under this plan various non-conventional and efficient conventional energy devices are distributed or installed among tribal populations, for betterment and improvement of the standard of living.

The Western Ghats Development Programme is implemented in 62 remote hilly talukas of 12 districts. Under this, various NRSE systems as well as efficient conventional energy devices such as improved kerosene stoves, improved kerosene lanterns and compact fluorescent lamps are promoted.

In Maharashtra, about 40 % of the total energy is used by industries. It is believed that 8 to 10% of this energy can be saved. With this view in mind the "Save Energy Programme" was started by MEDA.

The energy audit study helps to reduce energy consumption in industries. About 379 industries in the state have been audited, the results of which are encouraging. MEDA provides technical and financial assistance to industries for conducting energy audits.

Let's be energy crusaders



Laws of energy

In 1980, the National Energy Policy was framed to ensure adequate energy supplies and protect the environment from adverse impact of unregulated utilization of energy resources. Also, the Energy Conservation Act 2001, a statutory measure was formed to regulate energy efficiency and conservation due to an increase in the demand for electricity and fossil fuels and an increasing dependence on commercial energy. The Act tries to promote energy efficiency in the commercial sector, which is the largest user of energy. This would reduce the pressure on already existing resources and would be beneficial to the environment, as there will be a drastic reduction in greenhouse gas emissions.

Other laws

- Coal Mines (Conservation and Development) Act, 1974
- Electricity (Supply) Act, 1948
- Indian Electricity Act, 1910
- Mines Act, 1952
- Mines and Minerals (Regulation and Development) Act, 1957
- Motor Vehicles Act, 1939
- Oil industries (Development) Act, 1974
- Oil fields (Regulation and Development) Act, 1948
- Oil and Natural Gas Commission Act, 1959

Energy

people Power

We as the end users should also become aware of the serious effects of over-consumption and do our best to conserve energy. There are many ways in which we can do this.



- Switch off the lights and when you leave a room.
- Use fluorescent lamps. They use one fourth of the energy of regular light bulbs.
- Check and repair gadgets so that they function optimally at all times.
- Use public transport.
- Pool in private vehicles.
- Use a bicycle wherever possible.
- Buy products without much packaging and wrapping.
- Share toys, and books with others after you outgrow them.
- Use solar gadgets and appliances.
- Recycle/reuse newspapers, glass bottles, jars, steel, aluminum cans, foil.
- In industries, processes that are outdated and cause pollution, habitat degradation, global warming, energy loss, should be changed.





ACTIVITIES

ACTIVITY NO. 1: Electricity consumption survey

Objective: To find out about the use of electricity for various purposes and to understand the importance of the inculcation of simple conservation habits.

Background: Explain the concept of electricity conservation

Subjects covered: Social Studies, Science and Language.

Approach: Learning by survey and communication.

Materials required: Paper, pen and chart paper.

Method:

1. Ask the children to enlist the various electricity using appliances or things that they usually come across like fans, tube lights, lamps, pressing iron, mixers, at their school and at home i.e. everything that they see which uses electricity in some way or the other.
2. Instruct them to find out the purpose of using the enlisted appliances, and the average time for which they are regularly used. Make them prepare a data sheet consisting of the list of electrical appliances, usage duration and purpose of use.
3. In school different teams could be constituted and each team would be assigned to survey the particular appliance, e.g. there could be a fan group looking after only fans and a light group surveying only lights.
4. Ask each team to carry out the survey for three days, where they note down the approximate daily usage time of appliances and when used without any purpose. Collate the data and find out the duration of electricity being wasted.
5. Ask the children to take action and start a campaign by preparing charts and posters indicating electricity wastage in the campus and ask them to put the charts where they feel there was more electricity wastage.
6. Assign each child an appliance in school and ask him/her to go for rounds during intervals or break and ensure that electricity is not wasted through the appliance assigned to them.
7. Instruct them to switch off the appliances where they feel the electricity was being wasted.
8. Let them instruct or request the concerned people to use less electricity, make them visit every class in school and speak about the wastage of electricity that they surveyed.
9. Now let them collect the current month's electricity bills and compare with the previous ones, and find the difference; if there is none they need to work more on the project. Encourage children to repeat this exercise with the street lights in their locality, railway compartments, railway stations etc. and study the energy wastage and inform the concerned officials about the same.

FLASH!



Energy



ACTIVITIES

ACTIVITY 2. How much power do you want?

Objective: To make children realize that wants can be controlled when one decides to do so and suggest measures at individual and institutional levels to control wants and thus conserve electricity.

Background: Knowledge of energy usage in daily life and power generation.

Subjects covered: Social Studies, Art, Language, and Science.

Approach: Observation and Analytical.

Materials required: Paper to make 'Commitment Pamphlet' and pen.



Method:

1. Ask children to list down all those activities wherein electricity is consumed in the course of the day. (List should include personal, domestic, festive activities etc.)
2. Give them the situation that if electricity supply is reduced by 50%, which of the activities listed would they drop or eliminate. Let them mark a cross in front of the activities they prefer to drop.
3. Ask the children to give reasons for choosing or dropping of a particular activity. Also ask them alternatives for the same.
4. Based on the individual list explain to children that the activities they eliminated initially were the wants, while the activities retained are their needs.
5. Explain why we need to reduce our wants suggest measures of reduction energy uses which one can do without. (For example: the students might resolve to reduce they are wants like decreasing the use of battery-operated toys, decreasing the use of computers and television for playing games, etc.).
6. Ask the children to design a "Commitment Pamphlet" on the basis of their resolutions and put it up on the class notice board.
7. Encourage children to go around their locality and create awareness about reducing energy consumption.

ACTIVITY 3. Be an energy crusader

Objective: To make children understand various aspects of human influence on the environment and to train them in decision-making and in evaluating environmental issues from different viewpoints.

Background: Explain the role of humans in environmental damage and the role that can be played for the protection and conservation of resources.

Subjects covered: Social Studies and Science.

Approach: Role play.

Materials required: Paper and pen



Method:

1. Divide the children into 4 groups with at least 3-4 students in each group and name them as Politicians, Engineers, Environmentalists and Villagers.
2. Give an imaginary situation to each group such as:
 - Politicians: There is going to be an election in near future. Your party candidate is going to contest the election. Your election manifestoes: Building a dam on the River Annapurna (imaginary name). Electricity to villages and good market facilities for sugar cane and tomatoes. Substitute land on the slopes of the hill for the small land holders of two villages that will get submerged under the dam.





ACTIVITIES

- Villagers from 4 villages: Village 1: Mostly villagers who keep cattle and sheep, on the slopes of the hill from which the river flows. Village 2: Few kilometers away from the river on the western bank with some money lenders and rich farmers who own land and want to grow sugarcane and tomatoes. Village 3: Villagers practice agriculture on the fertile soil near the river few kilometers from riverbank. Village 4: Village with fishing community living adjacent to the bank of the river
 - Engineers: Who plan a dam and turbines to produce electricity, and also draw a plan to dig canals to provide water to Village 2.
 - Environmentalists: Who protest building the dam and canals. Their argument is that the dam will destroy the habitat of fish in the river; the villagers from village 4 will not only lose their land but will not be able to practice fishing; the fertile land will go under the dam; the villagers from village 1 will lose their fertile land and will be displaced somewhere on the slopes of the hill where they will burn the hill slopes and destroy the vegetation and try to grow crops further degrading the rich flora along the river; the sugarcane crops will increase the salinity of the soil and make it unfertile in the long run.
3. Based on given situations, each group prepares their points for a debate. (Ensure that there are no escalations of arguments, counter arguments and wrong interpretations. You could intervene whenever necessary)
 4. Give 20-25 minutes for the debate. It should end with the politicians announcing a new policy that will be accepted by all. (If the children are not able to draw conclusion then you could give some suggestions.).



ACTIVITY 4. How to get energy from garbage

Objective: To generate awareness about the energy that could be generated in your kitchen.

Background: Knowledge on Biomass and Biogas.

Material required: Kitchen waste, pen & paper, weighing scales.

Subjects covered: Science and Mathematics.

Approach: Experimentation and Observation.

Method:

1. Ask the children to identify the garbage which is biodegradable (vegetable, fruit) and weigh the daily kitchen waste generated in their home.
2. Ask the children to calculate the amount of waste generated per week and then per month.
3. Inform them that 1000 kg of kitchen waste gives 85 cubic cm of biogas and ask them to calculate the units of biogas that could be generated from their kitchen waste in a month.
4. Compare that with the amount of gas available in a gas cylinder and finally, calculate how much money could be saved if they switched to biogas instead of gas cylinder.
5. Encourage children to learn about the nearest biogas unit and visit it.



ACTIVITIES

ACTIVITY 5: How to make and use a solar cooker?

Objective: To learn making of a homemade solar cooker.

Background: Knowledge of solar energy and its applications. The Parvati solar cooker is a modified funnel circular unit that is 24 inches in diameter. The entire unit is made up of collector and reflector along with a stand to hold and cooking pots. The collector has three sections. Part A forms the base of the cooker, Part B forms the middle section and Part C forms the upper section. Stainless steel sheet also can be used as it is more durable. The collector would collect heat energy equivalent to about 300 watts.

Subjects covered: Science, Art, and Mathematics.

Approach: Practical demonstration.

Things required: Cardboard or aluminum or stainless steel sheet, scissors, brown paper, glue, aluminum foil, plastic cover, stand for cooking pots and cooking pots.

Method:

1. Cut the cardboard as per the dimensions given the figure.1.
2. Part C would be semicircle shaped with outer radius 24 inches and inner radius 16 inches. Join two end of this semicircle to form the upper section of cone.
3. Part B has outer radius of 12 inches, next circle would be of radius 11.3 inches and third circle of radius 4.8 inches. Part B would be 255 degrees section of circle. Join two end of this section to form the middle section of cone. Part B has collar space to join it to Part C.
4. Part A would have two circle of radius 4.0 inches and 3.6 inches. This collar space is for joining the base to part B.
5. Small V-cuts are to be made in collar space of Part B and Part A. Then bend these V-cuts on inside. This will make it easy to join together the parts together this is shown in Fig 2. To make the structure sturdy and durable paste brown paper on external surface of the cooker.
6. Construct the cooker as per the fig. 3.
7. For using the solar cooker use a metallic stand to place the conical reflector. Another small tripod stand is used to place the cooking pot. Take three pots in stacked position to cook the food. To retain the heat use a plastic cover for the same fit a plastic bag on the tripod.
8. For focusing of sun ray use a focusing pin. The focusing pin is made by a small metallic plate with a Nut bolt of 1/4 inch diameter and two inch long is fixed with two round washers at two ends fixed to the rim of reflector. When the cooker is properly focused shadow of upper washer coincides with the washer on the metal plate. As shown in figure 4. while focusing it is better to adjust position in such a way that shadow of upper washer is slightly on the west so that sun tracking error is taken care of.
9. Demonstrate cooking of the food such as rice which would take around 90 minutes. Encourage children to make each for their homes. For more details visit <http://www.angelfire.com/80s/shobhapardeshi/ParvatiCooker.html>

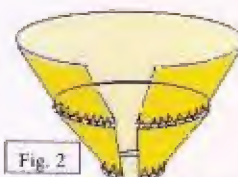
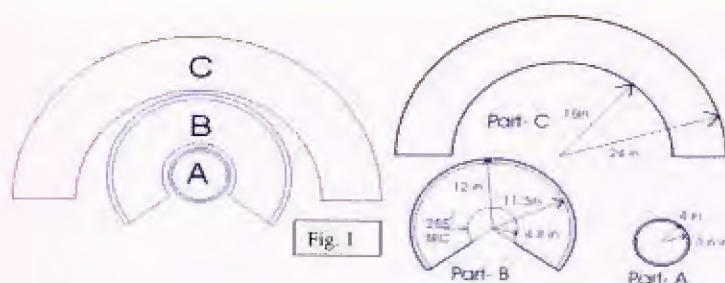


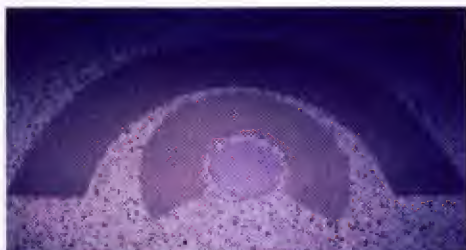
Fig. 2
Small V-cuts are made in collar space it makes easy to join the parts together





ACTIVITIES

Fig.3



Three sections are cut from the cardboard



Join two ends of part 'C' to make upper part of the cone



Join two ends of part 'B' to make lower part of the cone



Join all three parts to form the reflector



Paste aluminum foil or other reflective surface



Completed reflector



Reflector, Cooking pots, Stands, Plastic cover



Focusing Arrangement



While focusing, shadow of upper washer adjusted towards west



Stacked Cooking pots



Small stand is placed at bottom of the reflector



Stacked pots are placed on the stand



Plastic Cover is put on for green house effect



Left for cooking for about 90 minutes



People

'What does the forest bear? Resin, timber and foreign exchange,
so said the officer. The women instantly replied,
with their own slogan. 'What does the forest bear?
Soil, water and pure air, that are the basis of human life.'

A slogan from Chipko Movement

In this last chapter we deal with People who are the main consumers of the five elements we discussed in preceding chapters. Humans happen to be the 'fullstop' in the chain reaction of life and the web of life ends with us. Read more about us over here.

People and environment

- Is India an overpopulated country, its large and growing population a major cause of environmental destruction? It has been argued that the population pressure has outstripped the country's capacity to cope.
- The answer to this question lies in the report of a UN study which reported that India can feed 2.5 times its projected population at the turn of the century. But more than family planning, the answer lies in proper soil and water management.
- If there is poverty and hunger in the country today, or even apparent overpopulation, it is only because the country's scientists, politicians and planners have not learnt how to use the country's environment at a high level of sustainable productivity.
- In fact, the earlier production systems and social organization of tribals, nomads and various other traditional occupations and cultures which were based on sound ecological principles, are being rapidly destroyed in the name of economic development and modernization.
- The environmental destruction that has followed is making the lives of the Indian people humanly impossible, particularly of women who have to fetch for their daily household needs from the immediate environment.
- To survive, the poor often have no alternative but to turn upon the very environment with which they lived in full harmony in the immediate past.
- Millions of people today see no alternative for survival other than selling firewood from forests.
- A people biased development process, especially a women-biased process, would not only demand the restoration and enhancement of nature but would also bring about family planning and stabilize population.
- Consider the bare figures. Between 1901 and 1951, India's population grew from 238 million to 361 million, an increase of about 52% over 50 years. Between 1951 and 1981, it expanded from 361 million to 685 million, a whopping increase of 90% just 30 years. India literally added a second India in the 35-odd years of its independence.



- In 1967, an American book stated that India is heading towards dooms day and that the U.S.A. should not provide any aid to it. Fortunately, India's food production managed to keep ahead of its population growth, which helped it through some of the most critical years, like the of 1979.
- In 1983, the Food and Agriculture Organization (FAO) released an extensive study on the subject - Potential Population Supporting Capacities of Lands in the Developing World. The picture of India that emerged was both exhilarating and sobering. This is because India has enormous problems as well as an equally enormous natural resources base to solve these problems.



- Today, not only are we able to support our whopping population but are also exporting a variety of food articles to various developed countries.
- The Indian Agriculture Industry is on the brink of a revolution that will modernize the entire food chain, as the total food production in India is likely to double in the next ten years. As per recent studies the turnover of the total food market is approximately Rs.250000 crores (US \$ 69.4 billion) out of which value-added food products comprise Rs.80000 crores (US \$ 22.2 billion).

Glance at the past

Caste and Environment

- India has an estimated 40,000 castes that seemed to be rigid, hereditarily determined, hierarchical and oppressive, a social structure that lasted for many centuries.
- Madhav Gadgil, an ecologist and **anthropologist** Kailash Malhotra opine that the caste system brought in the discipline for usage of natural resources.
- Within the caste system, birth determines a human being's occupation. This creates an 'ecological space' which ensures that natural resources could only be used by a definite occupational group.
- This 'resource partitioning' helped in reducing competition, and hence conflict among human beings over scarce natural resources. This practice created a sense of responsibility as well as fear.
- People of each caste developed sustainable methods of resource utilization as they knew that if they exhaust their resources, they would not be allowed to access the resources that belonged to the other caste.
- The caste system is very much part of the society even today but there is no "resource partitioning" happening now. Growing modernization has destroyed the ancient sustainable and shared pattern of resource-use evolved over centuries.



People

Tribes of India



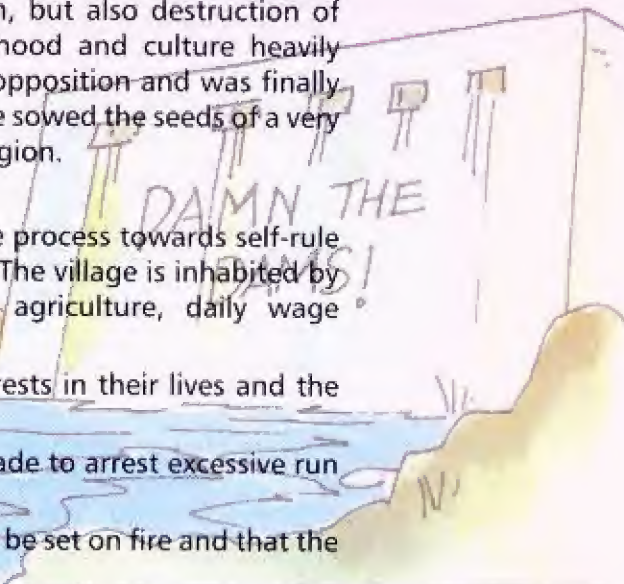
- About 75% of India's population lives in rural areas and about 18.74% of the total area of the country is occupied by tribals spread mainly over 21 states and union territories. Over 550 tribal communities inhabit the Indian subcontinent. Maharashtra alone constitutes the tribal population of about 5,772,038.
- Post independence development proved a disaster to the fragile system of tribal culture. The impact of modernization brought in change in occupations, loss of indigenous knowledge and land, poverty and self-insufficiency. Due to this some of the tribes are severely threatened.
- Tribal and rural people have a wealth of knowledge about nature that needs to be recognized, recorded, understood and tested. They have a thorough knowledge of local plant and animal species and understanding about ecological interactions. Many organizations in India have recognized this and are working towards recording this knowledge.
- The types, causes and effects of environmental degradation in urban and rural areas are very different. However we have lessons to learn from each other.
- Each tribal community has a distinct social and cultural identity of its own.
- They are known for utilizing the resources without disturbing the delicate balance of the ecosystem.
- Living close to nature, the tribals have acquired unique knowledge about the use of wild flora and fauna, most of which is not known to outside world.

Case 1: Self-rule at Mendha-Lekha, Gadchiroli, Maharashtra.

In the late 1970s, the government proposed two dams on the rivers, Godavari and Indravati, in the Gadchiroli region. For the economically poor tribals of the region, the project not only meant displacement from their traditional homes and possible social disruption, but also destruction of large stretches of forests on which their livelihood and culture heavily depended. Thus this project faced strong tribal opposition and was finally shelved by the government. However this struggle sowed the seeds of a very strong movement towards tribal self-rule in this region.

Mendha-Lekha was one of the villages where the process towards self-rule gained momentum and is today very successful. The village is inhabited by Gond tribals. People depend on subsistence agriculture, daily wage employment and forest produce.

- The villagers have realised the importance of forests in their lives and the need to protect and conserve them.
- Water and soil conservation efforts have been made to arrest excessive runoff and soil erosion from the forest areas.
- A decision has been taken that the forests will not be set on fire and that the



villagers will help in extinguishing fires.

- Fixed rules about resource extraction from the forests have been established along with penalties for the offenders.
- Villagers keep vigilance on the forests against illegal activities.
- Forests are protected from commercial activities, such as extraction of bamboo by paper mills.
- Villagers have managed to control encroachments in the surrounding forest.
- The village has also managed to get into a Joint Forest Management (JFM) arrangement, convincing the Forest Department to include, for the first time in the state, standing natural forests with diverse species in such a scheme, as against forests dominated by commercially valuable species.



Conservation - A tradition in India

Community efforts

In our country (as in many others) local **communities** set aside tracts of forest because they believe that the particular patch of forest belongs to a resident god who protects all life forms that are present within it. Sacred groves are found in many parts of India from Meghalaya in the northeast to Rajasthan in west and many parts of the Western Ghats. It is believed that some sacred groves have been in existence since the sixth century AD.

These 'Sacred Groves' have been protected over ages. As a result of protection, these groves harbor a great diversity of plant and animal life. The protection is so strict here that even grazing and hunting are prohibited; only the removal of dead wood, fallen fruits and some medicinal leaves is allowed. However due to increasing developmental pressure, and changing lifestyles and values of the communities that protect them, such forest patches stand endangered today.

Animals and plants species have been conserved by different traditional societies all over India.

Case 2: Sacred Groves

In Maharashtra the sacred groves are found in tribal as well as non-tribal areas. The groves in western part are called *devrai* or *devrahati* whereas in the eastern part Madiya tribals call it *devgudi*. Gadgil and Vartak documented 233 sacred groves from Thane, Raigad, Jalgaon, Pune, Satara, Kolhapur, Yewatmal, Bhandara and Chandrapur districts. A recent study by the BNHS shows existence of about 1600 groves in Maharashtra. The groves in the western and eastern parts of India, rarely allow extraction of resources. The **Sacred groves** form an important landscape feature in the deforested hill ranges of the Sahyadris.

<http://www.ces.iisc.ernet.in>,
www.ecoheritage.cpreec.org



People

Sacred Groves in Maharashtra



(Map courtesy: <http://www.india.gov.in/maps/>)

Nature Worship

- Our ancestors associated birds and animals with gods or goddesses
- Festivals helped in preserving nature in its pristine glory. For example, the day of *Vat-Pournima* married Hindu women worshiped the banyan tree for the betterment of their husbands. Snakes were worshiped on the festival of *Naag-Panchami*.
Bel or Bilva (*Aegle marmelos*) trees are associated with Lord Shiva.
- In Christianity, the first Commandment in the Holy Bible says that God created human beings to protect nature i.e. he created Adam and Eve and they were commanded to look after the Garden of Eden.
- Islam presents a way of life that encompasses an overall view of the universe, man, other life forms and the inter-relationships existing between them. The Holy Quran mentions: "God has granted all of us the inheritance of all sources of nature. Thus, the utilization and sustainable use of these resources is, in Islam, the privilege to all people. It follows that man should not distort environment because it must be inherited by future generations and remain permanently suitable for human life and settlement."



Case 3: People and Pelicans

An extraordinary case of an age-old conservation practice by an entire village community is the village Kokare Bellur in Karnataka. Grey pelicans and painted storks nest on the trees in the middle of the village and are given complete protection by the villagers.



Case 4: Towards... extinction!

In the hilly and forested regions of India live many tribal communities who speak different languages and have largely maintained their diverse traditions, which are quite distinct from the culture of their non-tribal neighbors.

The Andaman and Nicobar islands have been home to primitive indigenous tribes for tens-of-thousands of years. They are the last remaining nomads of hunting-gathering communities on earth.

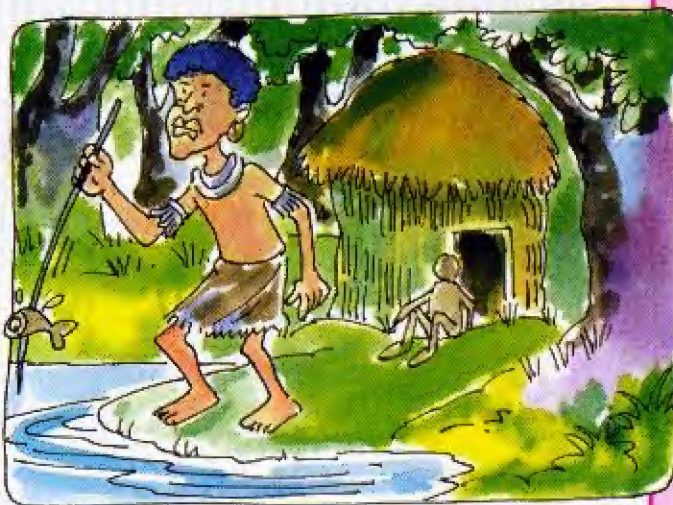
In the Andaman and Nicobar islands there are two distinct racial groups of primitive tribes viz **negritoes** in the Andamans (Great Andamanese, Onges, Jarawas and Sentinelese) and mongoloids in the Nicobar (Nicobarese, Shompens).

These tribes (especially Onges) are on the verge of extinction due to serious threat from ill-conceived development plans. And all this goes unnoticed under the name of protection and modernization.

The story begins in the late 1960s, when the Government of India planned a massive development and colonisation programme for the union territory of the Andaman and Nicobar Islands, without considering the fragile

environment of the islands and the rights of the Onges tribal communities.

Invasive tree felling brought about displacement of the Onges from their preformed habitat. The displaced tribes were



provided with temporary shelters against their traditional homes. This was further aggravated by migration of outsiders. With the influx of outsiders, the population grew and non-native food articles like rice, dal, oil and biscuits. The onslaught continues to threaten these tribes.

Bishnois and Conservation

The Bishnoi community of the Thar Desert in western Rajasthan is well known for its tradition of wildlife conservation. Some 500 years ago, the Thar was overrun by invaders from the west. Looting and plundering and killing were the order of the day. The cutting of trees, and killing animals for sport and trade became a way of life. This unchecked destruction wrought havoc in the form of drought and famine.



Guru Jameswarji from the same village, laid down certain principles that could help overcome the people's misery and taught them the significance of conserving trees and wild animals. He considered khejri (*Prosopis cineraria*) among trees, and blackbuck among animals, to be indices of environmental quality. The guru formulated 29 principles and thus his followers are known as Bishnois ("twenty-niners" in Rajasthani). The principles spread like wildfire among the villagers, when ecology in its present form was unknown. In the passion to preserve khejri tree, the Bishnois have no parallel in human history.

People

When Maharaja Ajit Singh ordered the cutting of Khejri trees for limekilns, the Bishnois protested their at the cost of their lives. The first woman to lose her life was Amrita followed by her daughters and other Bishnois. One by one their heads were chopped off in the protest against tree cutting.

The story goes that 363 trees were cut but only after 365 men, women, and children had been beheaded. The maharaja was shocked and, since then, no tree has been felled and no animals killed in Bishnoi villages. The twenty-fifth day after the full moon in September is a day of remembrance, when Bishnois gather at Khejri and pay their respects to Amrita and her daughters and all the 365 men, women and children who sacrificed their lives to protest the cutting of the trees.



The incident can be easily passed off as fiction, but the rich environment, density of trees, and large number of birds and antelopes visible today in Bishnoi villages, in stark contrast to the adjoining over-felled and wasted land, give credibility to the story.

The Situation today

Urbanization

- During the last four centuries, especially after the industrial revolution, human lives changed very rapidly. Rural people began to leave farms and rush towards cities for jobs. Lack of job opportunities in rural areas, repeated droughts, and food shortages and lust for a seemingly better life in cities all these accelerated migrations from rural regions to industrial centres. This was the process of urbanization.
- Urbanization becomes difficult for a government to manage when there is a rapid movement away from the rural areas to the cities.
- The growth of urban populations also strains the capacity of many developing countries to provide basic amenities to all residents. The poor, in some cities, have no better life prospects or public services than those in rural areas. Besides, migrants from rural areas also face similar problems. Still, there are no signs of slowing down in shift from rural to urban areas.
- The increased urban population strains the environment. This results in pollution and other environmental problems which have ill effects on the health of the people. This cycle continues over years together. In the long run, both the urban as well as the rural populations become victims of poor lifestyle.



Poverty

Poverty is said to be both the cause and effect of environment degradation. As population grows, more and more natural resources are exploited to meet the needs of increasing populace. The people who have buying power get the resources while others do not get even their basic needs satisfied.

- There is an uneven distribution of resources in the world per capita availability of resources like food, water and energy.
- In developed countries the population is less compared to that in developing countries. But the food, water and energy consumed by each person in developed countries is much more than in developing countries.
- About one-fifth of the world's people live in the developed countries in the Northern Hemisphere. These people use two-thirds of the world's resources.
- There is a problem of over-consumption and waste by a few at the expense of the majority, not just by rich nations but even by the rich in poor nations.
- Affluent people utilize the resources more, while the people who live below the poverty line may not be able to use them even to the bare minimum level.
- Today, nearly 60 per cent of the world's poor live in fragile and highly vulnerable areas in arid and semi-arid lands, on steep slopes and forests.
- Poor people, who cannot meet their subsistence needs through purchase, are forced to use common property resources such as forests for food and fuel, pastures for fodder and ponds and rivers for water. However, the irony is that, these resources are accessed for urban supply too. Thus, one has to face the immediate brunt of exhausting natural resources and subsequently, natural disasters.

Clean drinking water facility is available to only 65.5 % of rural households and 97.4 % of urban households in Maharashtra, and to 68.7 % of rural and 91.4 % of urban households in India.

States	Population in millions	
	Rural	Urban
Maharashtra	560	410
Gujarat	320	190
Madhya Pradesh	440	160
Chhatisgarh	170	40
Andhra Pradesh	550	210
Karnataka	350	180

People

Case 5: Death wish

Maharashtra is one of India's most prosperous states - but despite that, farmers have been committing suicide for the past three years in despair at crop failure, drought and growing indebtedness. According to statistics provided by the Cotton Growers Association of Maharashtra, 330 farmers in the cotton and soya bean-growing region of Vidarbha have committed suicide in the last three years. Government officials told BBC News Online there were no solutions or suggestions to tackle the problem of failing crops, and farmers unpaid debts led to the suicides. Poor monsoon rains add to the problem.

The government hasn't given anything to the farming families, not even the 100,000 rupees promised by the state government to the dependents of farmers who committed suicide. Vidarbha's distraught farmers said they want early justice - and if no justice is given, the government would face the consequences in the form of electoral revenge when state elections are held. <http://news.bbc.co.uk>

Bad health

- The irrational use of natural resources leads to shortage of these resources and pollutes the environment. We are forced us to realize that health and environmental issues cannot be dealt with, in isolation. They are intricately linked.
- Changes in one manifest as effects in the other eg. Washing away of iodine and other nutrients from soil due floods and soil erosion leads to iodine deficiency among the people in the Himalayan belt and Gangetic plains. This leads to health problems like goiter. Iodine deficiency in pregnant women can result in miscarriages or the necessity for abortion, still births, birth of deaf-mutes, or brain disorders in infants.
- Food shortage, contaminated water, polluted air and unhygienic conditions due mismanagement of waste has lead to one of the major problems of malnutrition in India. Malnourished children are less likely to perform well in school and more likely to grow into malnourished adults. They are at greater risk of disease and early death. About 50 per cent of all childhood deaths are attributed to malnutrition. The prevalence of malnutrition varies across states, with Madhya Pradesh recording the highest rate (55 per cent) and Kerala among the lowest (27 per cent).





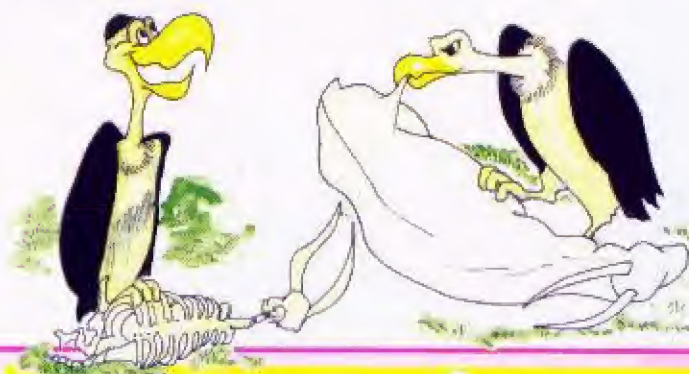
Case 6: Towers of silence

Vultures are valued in Indian society for their role in environment protection. They have an important cultural and religious significance. The Parsees depend upon vultures to remove their dead. The ancient Parsee religion holds the earth, fire and water sacred and to avoid contaminating them, the Parsees dispose of their dead by placing them on high Towers, where vultures rapidly strip the bones and flesh. The dead serve as food for these birds and become a part of the ecosystem.

Vultures, the foremost scavenging birds, have been on the path of extinction for sometime now. There has been a catastrophic decline in the number of native "Gyps" species of vultures in the Indian subcontinent. The untimely decline of vultures has been due to a drug diclofenac, that is commonly used as a painkiller for cattle. Diclofenac kills vultures that feed on the dead bodies of livestock that have been given the drug.

A team of scientists led by Gerry Swan of the University of Pretoria, found that the drug Meloxicam was a safer alternative. It has recently become available for veterinary use in India and could easily be used in place of Diclofenac. The vulture issue has gained national importance and has got full support from the present Prime Minister Manmohan Singh.

The BNHS in collaboration with the Royal Society for Protection of Birds has established a vulture captive breeding centre near Panchkula, Haryana. Phasing out of diclofenac and establishment of more vulture captive breeding centers, would hopefully ensure the survival of the threatened species.



Good news honey... they have taken our case to the PM and they succeeded

People

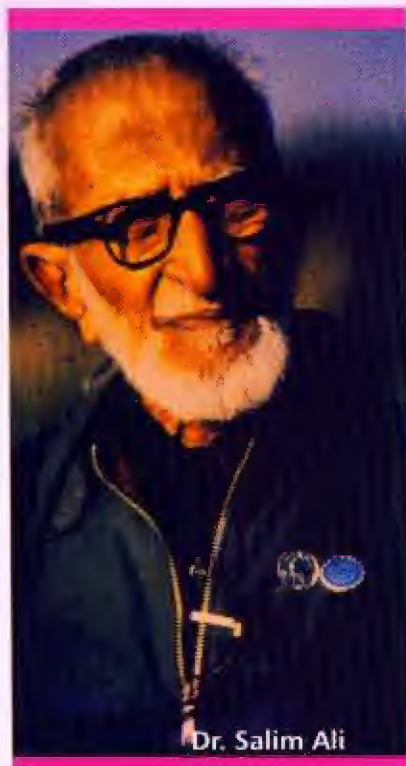
Case 7: Minamata in India

In May 1956, people from Minamata and the nearby fishing villages in Japan, showed symptoms like severe convulsions, bouts of psychosis, loss of consciousness, coma and death. It was found that a common factor of all the victims was that they all ate large quantities of fish from Minamata Bay. Medical research tentatively concluded that the deaths were caused by mercury poisoning through the consumption of contaminated fish and shellfish. Soon, it became clear that the poisonings were linked to a production factory, owned by the Chisso Corporation in Minamata, making a type of plastic (acetaldehyde and PVC) where mercury was used as a catalyst.

In Kodaikanal, the Department of Atomic Energy (DAE) found that the mercury level there was 1.32 mg per cubic metre, about 2,640 times higher than the normal level of 0.5-10 nanogram per cubic metre.

For nearly two decades, the Hindustan Lever Limited's (HLL) thermometer factory has been dumping mercury wastes down the hillside into the Pambar Shola forests. Mercury vapours escaping from the factory have had adverse effects on the lives of its more than 1,000 workers. The contamination is to such an extent that traces of the deadly metal was detected in lichen samples from the forests. Slowly the years of rampant chemical pollution are manifesting in the employees. Already 17 workers (average age 32) have died of mercury poisoning.

Many families living around the factory are grappling with serious health problems as a result of poisoning. Women have been affected the most because being at home they are continually subjected to mercury vapours being forcefully blown out by the fans in the factory workplace. Kodaikanal has an alarmingly high number of renal diseases.



Dr. Salim Ali

The brighter side

- As people become aware of the current local as well as global issues on environment, they have realized that the only way to ensure the survival of humans on the Earth is by protecting all the other forms of life and limiting the use of its natural resources. People of all ages, sex and community are slowly coming together to save our planet.
- There have been a number of individuals who have played a key role in improving the environment conditions of our country. These are:
- Salim Ali (1896-1987), an ornithologist. He was our country's leading conservation scientist and influenced the environmental policies in our country for over 50 years
- Indira Gandhi (1917-1984). The late Prime Minister played a very important role in preservation of Wildlife in India. It was in her period, that The Wildlife Protection act was formulated. The prestigious Tiger Project was also formulated under her leadership.
- S.P.Godrej (1912-2000), India's greatest supporter of wildlife conservation and nature awareness programmes. He played an advocacy role in the wildlife conservation. He was awarded the Padma Bhushan in 1999 for his conservation activities.
- M.S.Swaminathan (1925). One of India's foremost agricultural scientists, he has been concerned about biodiversity. He founded the M.S. Swaminathan Research Foundation in Chennai. This institute is involved in research work on conservation of biological diversity.

- Madhav Gadgil (1942), a well known ecologist has a variety of interests ranging from animal behaviour to recording biological diversity of an area. He is the editor for the series on *Lifescapes of Peninsular India*.
- M.C. Mehta is India's most famous environmental lawyer. He has filed several Public Interest Litigations for environment conservation. Some of his famous, continuing battles are for protecting the Taj Mahal, cleaning the Ganga and initiating the government to incorporate environment education in schools and colleges.
- Anil Agarwal (1947-2002) was a journalist and founder of Centre for Science and Environment, a non-governmental organization that supports environmental issues with scientific and statistical proof.
- Sunderlal Bahuguna (1960) has become internationally known for his conservation action program through the efforts of local people. The Chipko movement was revived by him in the Garhwal hills.
- Anna Hazare (1940) is an Indian social activist. He served in the army till 1975 and then sought voluntary retirement to serve the people of Ralegan village, which was reeling under utter poverty. The village had no supply of drinking water, no agriculture, no jobs but illegal liquor shops that were mushrooming all over the place, destroying peoples' physical health, their social and moral fibre. Hazare renovated a temple with his provident fund and gratuity. He realised that religion could be the medium of educating people towards living a sustainable life and make their village self sufficient. He helped the poor people of Ralegan Siddhi to gain economic growth, spiritual fulfillment and education.

It's our turn

It is now evident that we humans suffer from our own doings. We have to awaken to the fact that only we can help ourselves. We need to adopt a lifestyle that is in harmony with nature. Besides the facts given in earlier chapters, we would like to provide some additional ones here.



Sustainable lifestyle

- The need for development is as great as ever, but the environmental impacts are increasing too.
- It is certainly a challenge, and one that is becoming larger. In the past, economic activity meant more pollution and wasteful use of resources. Now, we have to spend millions to clean up the mess.
- Besides, we have to find a new way forward. This is the challenge of sustainable development. For the future, we need ways to achieve economic, social and environmental objectives and consider the longer term implications of decisions.
- We need to improve the efficiency with which we use resources and we need international co-operation to overcome environmental problems, to allow trade to flourish and to help the world's poorest people as we move towards a more global society.



poorest people as we move towards a more global society.

In the earlier chapter we listed activities which one can follow to make this Earth a better place to live on. Here are some more ways by which you and your family can adopt a sustainable lifestyle.

People

Here are some more ways by which you and your family can adopt a sustainable lifestyle.



- Don't use pesticides, herbicides or chemical fertilizers in farms. Use leaf litter, garden waste, kitchen waste and cow dung as fertilizers, pesticides.
- Recycle paper, cardboard, glass, plastic, and whatever else your local recyclers will accept.
- Buy, eat and grow organic foods. They are grown without pesticides, herbicides, or chemical fertilizers.
- Don't burn paper, wood, trash or anything else unless it is absolutely necessary.
- Combine trips to take care of the shopping to limit driving and save gas.



- A pressure cooker can save 75% of the energy required for cooking.
- Keep vessels covered with a lid during cooking. This helps to cook foods faster and saves fuel.
- Use rechargeable batteries. Although they may cost more to buy, rechargeable batteries will save you 10 or 20 times the original cost (by not buying new batteries over and over again). Also, they will not add to the hazardous waste, by being thrown into the trash. Minimise the use of batteries. Use a cord (AC adapter) for radios and other appliances when possible
- Limit your family size by practising birth control. We no longer enjoy the luxury of having large families. Every time another child is born it adds to the burdened resources of this planet. We are living longer now; which means that we have lesser space for newborns on this planet.



- If you have a leaking tap or pipe, get it fixed. But, what about the time before it's fixed? Put a pan, bowl, or cup underneath to catch the water, and use it for something else like watering a plant, cleaning, cooking, or drinking! There's nothing wrong with the leaked water; it came out of the same tap.
- Don't use disposable products. Diapers, pens, razors, towels; they all come in reusable as well as disposable forms. Use cloth diapers instead of disposable plastic ones. Don't use disposable paper towels. Put your old clothes (tee-shirts or towels) to use as rags. Don't get trapped into the world of simple disposable items just because "it's easy and convenient."
- Spread the word about conservation. Anyway you can, get people to think about the earth. Always look for environment-safe products and encourage others to do the same. From recycling to buying less packaging to planting trees to saving water to conserving energy, keep the environment in mind.



Case 8: Eco-farming

In Punjab, many of the farmers are practicing eco-farming. These farmers adopted organic farming over chemical farming that involved fertilizers and pesticides. The farmers use a variety of natural products like neem oil, pongamia, ash, cow urine and cow dung, vermicompost etc., to replace chemical pesticides and fertilisers.

With organic farming, their crop yield was better as local varieties were used instead of the genetically modified seeds. Organic farming leads to crops which are resistant to pests and other infections.



Case 9: Women Power

In the small village of Khirakot in Almora district in Uttar Pradesh Himalayas, the women work on the fields and fetch fuel and fodder from the nearby panchayati forests. The women protect the forests by fencing them off and restricting the cutting of grass in the protected patch.

Once, a contractor from Kanpur got the lease for mining in the hills. The mining brought in a variety of problems to the forest. Soil erosion, habitat degradation and air pollution were some of the major threats. The women realized that they need to fight back to save their resources. First they asked the

men to negotiate with the contractor. When the talking did not help, the women stopped the contractor's workers and did not allow them to dig. The women demanded that if the contractor continued his work, they would sacrifice their own lives. The contractor tried all means of convincing them, but they did not get carried away.

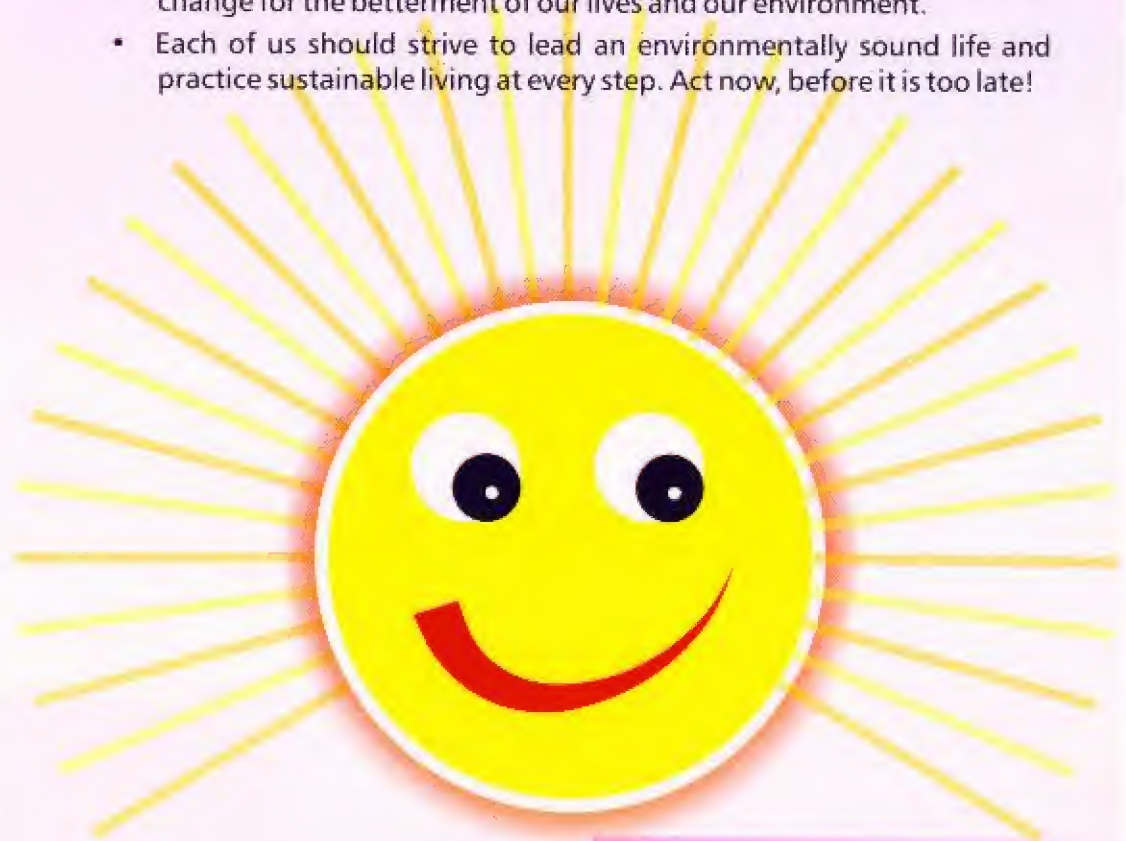
Finally, the district magistrate was taken around the area and shown the destruction; he recommended that the lease be cancelled. Finally the mines were closed down. The women filled the ditches, built walls to protect their fields and planted oak trees to preserve their forest.



People

We can make a difference

- Very often there are several situations like tree cutting, noise pollution during festival time, vehicles giving out black exhaust, polluting industries, unattended public garbage bins, trapping & ill-treatment of animals, injured/helpless animals, polluted water bodies, careless use of banned pesticides on roadsides, farms and gardens and many more, happening around us. Most of the time, we are least bothered; however there are times when we wish we could do something. This is possible if one is aware of the ways in which one could help.
- Every individual is expected to know the law. A fundamental principle is that "ignorance of law is not excusable." However, the fact remains that most people are unaware of the law and of their legal rights.
- Often, people play the role of mute spectators to many serious problems that threaten their peaceful lives, primarily because they are ignorant of their rights under the law.
- One such problem is the various types of environmental degradation which every citizen faces, such as the exhaust from automobiles, the obnoxious smells from open drains, loud music and other noise, polluted drinking water, and so on. These problems can be solved with the aid of specific laws that have been formulated for the purpose.
- One may not always be of great help but a small contribution could make a big difference. One way is to contact your nearest local environment organization or individuals working for this cause.
- Writing to your local newspaper is the best way to draw attention of your local authorities towards any issue.
- Finally it all depends on us, whether we feel the need to bring about a change for the betterment of our lives and our environment.
- Each of us should strive to lead an environmentally sound life and practice sustainable living at every step. Act now, before it is too late!





ACTIVITIES

ACTIVITY 1: The crowded world

Objective: To understand how stress imposed by population size varies according to availability of resources

Background: to understand the ill effects of the growing population, the measures that could be taken.

Subjects covered: Science and Social Studies.

Approach: Learning by game and understanding space requirements of other life forms.

Materials required: note book, pen and blindfolds.

Method:

1. Clear part of the classroom of all furniture. Blindfold five students and ask them to slowly walk around at the same time in the given area. Each student should keep count of the number of times he/ she bumps in to another student. After 3 minutes ask them to stop and record the number of times each student has bumped in to another.
2. Repeat the game with 10 students, 20, 30, etc. makes sure that the duration of the game in each case is identical. Note readings of each game.
3. Now take the students outdoors. Cordon off a suitable area and repeat the same game with same number of students in the class. Vary the space area in each game.
4. For each game recorded, both indoors and outdoors, calculate the relationship between the frequency of bumping and the degree of crowding. (i.e. the proportion of number of students to space available)
5. Explain how the space is a resource, just like money, food, etc. and how the pressure of population on resources causes stress.
6. Ask if a packet of 100 sweets is distributed in the class, how many would each student get? If the class were half its size, how many would each get? Discuss with them taking several examples of space and limited resources and the problems caused by growing population.



ACTIVITIES

ACTIVITY 2: Utilization of limited resources

Objective: To make the students understand that resources are not increasing therefore sustainable practices are required to meet the requirements of increasing population.

Background: Explain to the students the importance of sustainable living and how this can help in the current scenario of growing population.

Subjects covered: Social Sciences.

Material Required: paper, 5 coloured crayons /5 coloured chalks, blackboard

Approach: Learning by game and understanding

Method:

1. Make three groups of students, every group double the size of the previous group.
2. Draw a big circle on the board and tell the students that we have limited resources (coloured chalks) which have to be utilized in the space (circle) provided in a given time.
3. The smallest group gets the first chance to draw. They get all 5 chalks and one minute to draw whatever they want. Each member should get a chance to participate.
4. Then the second group gets the chance to draw whatever they want inside the circle, but they get only three chalks and one minute.
5. The largest group gets a turn at the end to draw inside the circle with only one chalk and one minute.
6. Ask the students what each group felt during the time given. Allow them to express their feelings.
7. Explain that the chalks that represented the resources are depleting day by day and the population consuming these resources is continuously increasing.
8. Discuss with the students what if there is one more group to draw (to use the resources)? Ask the students to resolve the problem. Where can the resource utilization be minimized in our daily activities?



ACTIVITIES

ACTIVITY 3: What is the natural resource use pattern in your area?

Objective: To enable students to identify how natural resources are used in their surroundings.

Background: Explain to the students the importance of natural resources like water, air, land etc. and their different exploitation patterns

Subjects covered: Science and Social Studies

Approach: Learning by survey and understanding

Material: paper and pencil

Method:

1. Discuss with the students different purposes for which various natural resources are used-like water for food, for washing clothes for bathing, or lands for various agricultural practices, residential, commercial etc. or wood as fuel, as construction material etc..
2. Give the students a list of probable areas where natural resources are used extensively.
3. Take the students for walk in the neighborhood areas around the school. Ask them to carefully observe how resources like water, land, sun are used in that particular area. Ask them to record their observations and mark in the categories in the given list.
4. Also instruct them to note down any misuse or overexploitation of the resources they are coming across.
5. Ask them to visit the area again and interview some elders living in the area. Help them to put together list of questions to be asked.

For example:

What are the various changes they have seen in the land use pattern?

What could be the various problems they come across due to shortage of resources?

What could be the suggestible solutions?

Whether they know about something called solar energy?

Do they feel any pollution in air by using wood as fuel?

Are they happy using dung cakes as a fuel?

5. Discuss, in class, the various areas utilities and where the overexploitation can be reduced?



ACTIVITIES

ACTIVITY 4. My world, my future

Objective: To encourage children to think of a sustainable world.

Background: Understanding that sustainable living is the only way our survival on Earth is ensured.

Subject: Art, Language, Social Studies.

Approach: Hands on experience.

Materials required: Old magazines, newspaper, scissors, glue, chart paper coloured pens.



Method:

1. The previous day, ask each child to bring the above given materials from home. The next day give the class a theme- 'How do they wish their world to be in the future?' Give them 25 minutes to come up with a visual using all the materials.
2. Ask some students to present what changes they will have to make from now to ensure their future world becomes like the one in their artwork.

ACTIVITY 5. Quality of life

Objective: To encourage children to understand the meaning of 'quality of life'.

Background: Quality of life is different from standard of living. While standard of living refers to consumption of goods and services, it may not mean that that will give you a better quality of life.

Subject: Social Sciences and Science.

Approach : Story narration.

Materials required: paper and pencils.

Method: Tell the children this story.

"In a village of Rampur, in Maharashtra, a long time ago people used to live a quiet, peaceful life. Farmers would till fields, women would fetch fruits and berries from the forest and grazers would spend long hours in the grasslands grazing their cattle. Food was available in plenty as the population of the villagers was not very large and plentiful water was available due to a good forest that acted as a catchment for the rain water.

One day a business tycoon came to the village and decided to build a cold drink factory here. A lot of forest trees were chopped for making the huge factory and when the villagers protested; he offered a job in his factory to the village youth.

The youth got jobs in the factory and forgot how to farm and rear sheep. Not long after women started finding less food in their cut down forest and the business tycoon started importing food from other areas and sold it to the villagers at a high price. The fresh water started getting polluted due to the factory effluents and people started getting sick. Soon the Local Panchayat requested the government to set up a dispensary in the village. The government says the number of illnesses in the village has increased and opened up a large clinic in that village."

Ask the children what did they understand about standard of living and quality of life from this story.



ACTIVITIES

ACTIVITY NO.6 Saving the environment during festivals

Objectives: To make the children understand the true spirit behind some of our festivals

Background: Explain how the festivals, which originated to save the environment are destroying it due to ill practices.

Subject: Social Science.

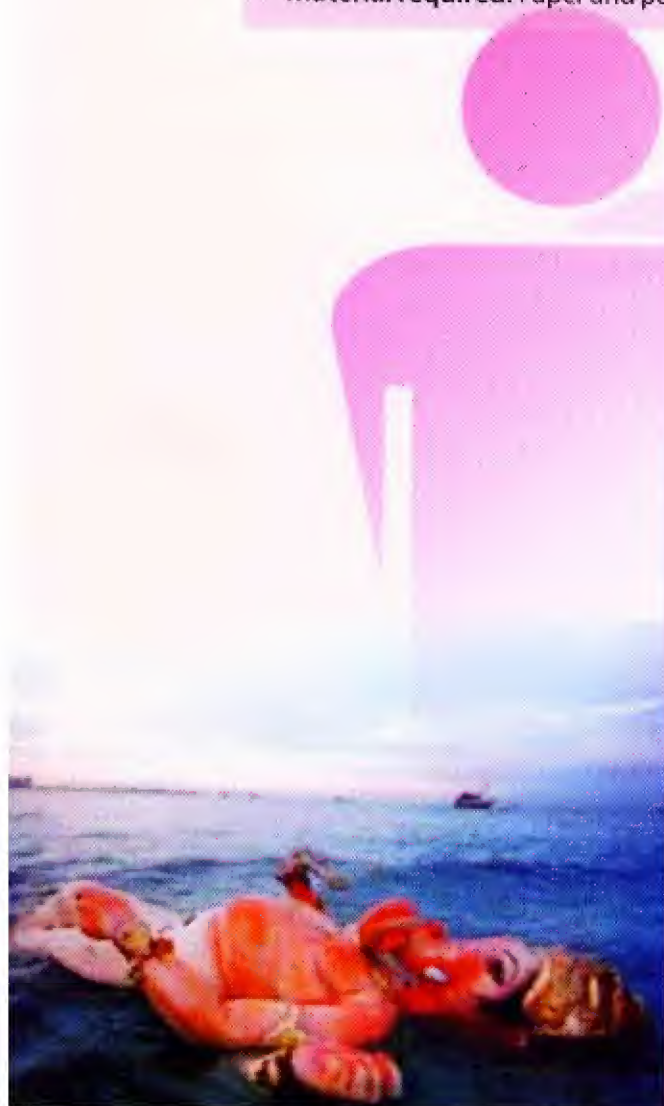
Approach: Hands on experience.

Material required: Paper and pens and drawing material, chart papers etc.

Method:

1. Tell the children the significance of the festivals in conserving environment.
2. Divide the students in smaller groups of 4-6 (based on the locality they stay in).
3. Give them a questionnaire and ask them to collect data as to how many ladies celebrate festivals such as, Naag Panchami, Vat Pournima, Dassera and Mahashivratri . How are these festivals celebrated ? How many housing societies burn tree parts during Holi?
4. From the data collected, find out the households which harm the environment in celebrating these festivals.
5. Appeal them to celebrate these festivals in the right spirit
6. Ask the children to write slogans, make posters to create public awareness of (e.g. myths and facts about snakes, dangers of deforestation, the harm caused to the environment by celebrating these festivals in a wrong way etc.)
7. The children can put up the posters prepared by them on the notice boards of the housing societies.
8. In rural area the posters can be displayed in the 'chowks' or the evening meeting places of the villagers.

The children should be asked to write an essay to express their views and their suggestions in celebrating these festivals.



Useful Information

List of Resource Organizations

1. AVEHI- Audio-Visual Resource Centre, Ravali Camp, Sion Koliwada, Mumbai- 400031.
2. Bharati Vidyapeeth Environmental Education Research Institute (BVEERI) 4th Floor, College of Architecture Building, Bharati Vidyapeeth, Pune-Satara Road, Katraj, Pune- 411 043.
3. Bombay Natural History Society, Conservation Education Centre, Near Filmcity, Goregaon (East), Mumbai - 400 065.
4. Center for Environment Education, Thaltej Tekra, Ahmedabad- 380054.
5. Central for Cultural Resources and Training (CCRT), Bhawalpur Houses, Bhagwandas Road, New Delhi 110 001.
6. Centre for Science and Science and Environment (CSE), Audio- Visual Unit, F-6, Kailash Colony, New Delhi 110 048.
7. C.P.R Environmental Education Centre, 1, Eldams Road, Chennai- 600018.
8. Maharashtra Nature Park, Opp. Dharavi Bus Depot, PMGP Colony, Dharavi, Mumbai 400017.
9. National Council of Educational Research & Technology (NCERT), Sri Aurobindo Marg, New Delhi 110 016.
10. Tata Energy Research Institute (TERI), Darbari Seth Block Habitat Place, India Habitat Centre New Delhi- 110 003.
11. Uttarakhand Seva Nidhi, Champa Naula, Manorath Sadan, Almora, Uttar Pradesh 263 601.
12. World Wide Fund for Nature- India (WWF-I), 171-B, Lodi Estate, New Delhi- 110003.

List of Internet Sites for Environmental Issues

Name of the Websites

1. www.Stigers.org
2. www.animal.discovery.com
3. www.bagheera.com
4. www.barkingbuddies.com
5. www.bbc.co.uk/reallywild
6. www.biodiversity.environment.gov.au/threatened
7. www.birdlife.org
8. www.bnhs.org
9. www.britanica.com
10. www.bugbios.com
11. www.care2.com
12. www.cceindia.org
13. www.conservation.org
14. www.corporatewatch.org
15. www.cozucare.org
16. www.defenders.com
17. www.earthlink.co.au
18. www.earthsystems.org
19. www.ecorcycle.vic.gov.au
20. www.enature.com
21. www.endangered.fws.org
22. www.endangeredspecies.com
23. www.enn.com
24. www.envfor.nic.in
25. www.envirolink.org
26. www.environment.about.com
27. www.essential.org/mrc
28. www.geocities.com/rainforest/298

Name of the Websites

29. www.greenindus.com
30. www.greenpeace.org
31. www.igc.apc.org/ran
32. www.irn.org
33. www.iucn.org
34. www.kidsplanet.org
35. www.mpforestchief.com
36. www.nationalgeographic.co.in
37. www.navneet.com
38. www.nwf.org/kids
39. www.PETAIndia.com
40. www.sanctuaryasia.com
41. www.seaworld.com
42. www.stopextinction.org
43. www.theecologist.com
44. www.traffic.org
45. www.wcmc.org.uk
46. www.panda.org
47. www.unep.ch
48. www.vic.waterwatch.org
49. www.wcmc.org.uk
50. www.wii.gov.in/envhome/Eindex
51. www.wild.allindia.com
52. www.wildlife-vidarbha.org
53. www.worldwatch.org
54. www.worldwildlife.org
55. www.wri.org/oceans/index.html

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Design Team : Nelson R., Savio M. & Aarti T., E-mail : nelexl@yahoo.com

Printed at Anitha Art Printers, Tel.: 2665 2970/78, www.anitaprinters.com

DATES	EVENTS
12 th January	International Youth Day
14 th - 30 th January	Animal Welfare Fortnight
2 nd February	World Wetlands Day
28 th February	National Science Day
21 st March	World Forestry Day
22 nd March	World Day for Water
23 rd March	World Meteorological Day
7 th April	World Health Day
22 nd April	Earth Day, Water Resources Day
28 th April	World Heritage Day
1 st June	International Volunteer Day
5 th June	World Environment Day
17 th June	World Day to combat desertification and drought
1 st July	Vanmahostav Day
6 th August	Hiroshima Day
9 th August	International Day of World's Indigenous people.
5 th September	Teachers Day
16 th - 18 th September	Clean up the World Campaign
2 nd - 8 th October	Wildlife Week
2 nd October	International Natural Disaster Prevention Day
4 th October	World Habitat Day
5 th October	World Animal Welfare Day
11 th October	International Day for Natural Disaster Reduction
16 th October	World Food Day
24 th October	World Development Information Day
1 st - 7 th November	World Ecology Week
14 th November	Children's Day
19 th Nov. - 18 th Dec.	National Environment Month
24 th November	World Biodiversity Conservation Day
2 nd December	Zoo Week/Bhopal Gas Tragedy day
3 rd December	World Conservation Day
29 th December	International Day for Biological Diversity





Aishwarya Rajesh

IN HARMONY WITH NATURE

A Teacher's Handbook on Learning for Sustainable Living in Maharashtra

This publication has been developed to provide support materials and activities that assist in understanding the concept of sustainable living. It has been developed after a series of workshops with teachers, and in consultation with other professionals. It has been designed for secondary students and can be adapted for younger and older age groups.

Both the language and style used are simple and easily accessible to parent's and teachers wishing to help youngsters in using the resource. The information and activities included here are not prescriptive and can be adapted to meet different needs.

The aim of this book is to make each one of us review our lifestyle and behaviour so that we can then evaluate our impact on the environment and initiate appropriate environmental action.



Bombay Natural History Society

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Website: www.bnhs.org